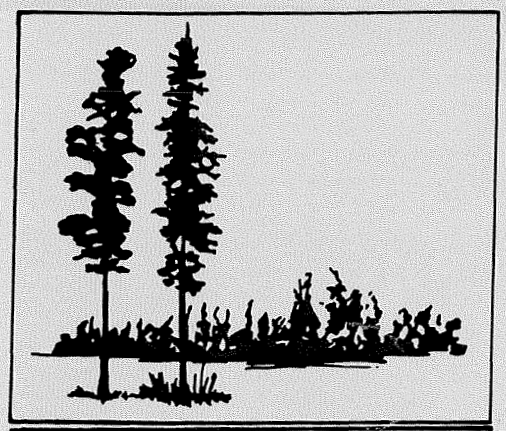

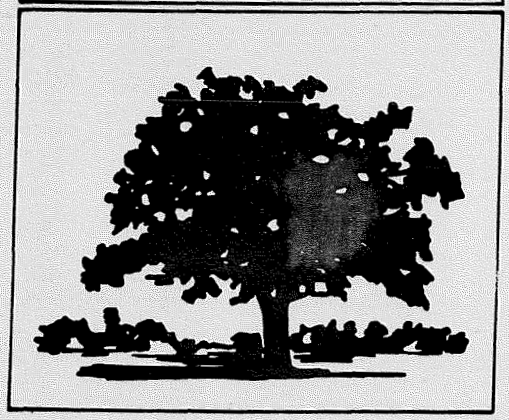

FOREST PEST CONDITIONS IN WISCONSIN

ANNUAL REPORT 1981

DEPARTMENT OF NATURAL RESOURCES
BOX 7921
MADISON, WISCONSIN 53707

FOREST PEST CONDITIONS IN WISCONSIN ANNUAL REPORT - 1981

Compiled and Edited by Donald W. Renlund
Supervisor, Forest Pest Control

DEPARTMENT OF NATURAL RESOURCES
Division of Resource Management
Bureau of Forestry

PREFACE

This record of the activities of forest pests and other destructive agents of growing trees in Wisconsin's forest nurseries, plantations, and natural timber areas was made possible by the dedicated work of pest management personnel in each district and at the Forest Pest Management Laboratory at Nevin Hatchery in Madison. DNR foresters, other department field personnel, cooperators in other public agencies and private forest industry contributed valuable assistance in monitoring the forest lands in all classes of forest ownership.

Preparation of the annual report is the result of the concerted efforts of staff personnel at the Pest Management Laboratory who prepared the final drafts and guided them through typing at the Southern District Office. The finished product was prepared by the Bureau of Office Services. A special note of appreciation is extended to Phil Pelletteri and Steve Krauth, University of Wisconsin Entomologists, who over the years have identified many insect specimens submitted by the Forest Pest Management Unit. Their dedicated service has been essential to our approaches to new and unusual pest situations.

Many thanks to all who have contributed to the report at any point along the way. Your help was appreciated.

Donald W. Renlund, Supervisor
Forest Pest Management

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Forest Pest Control Personnel - January 1, 1982

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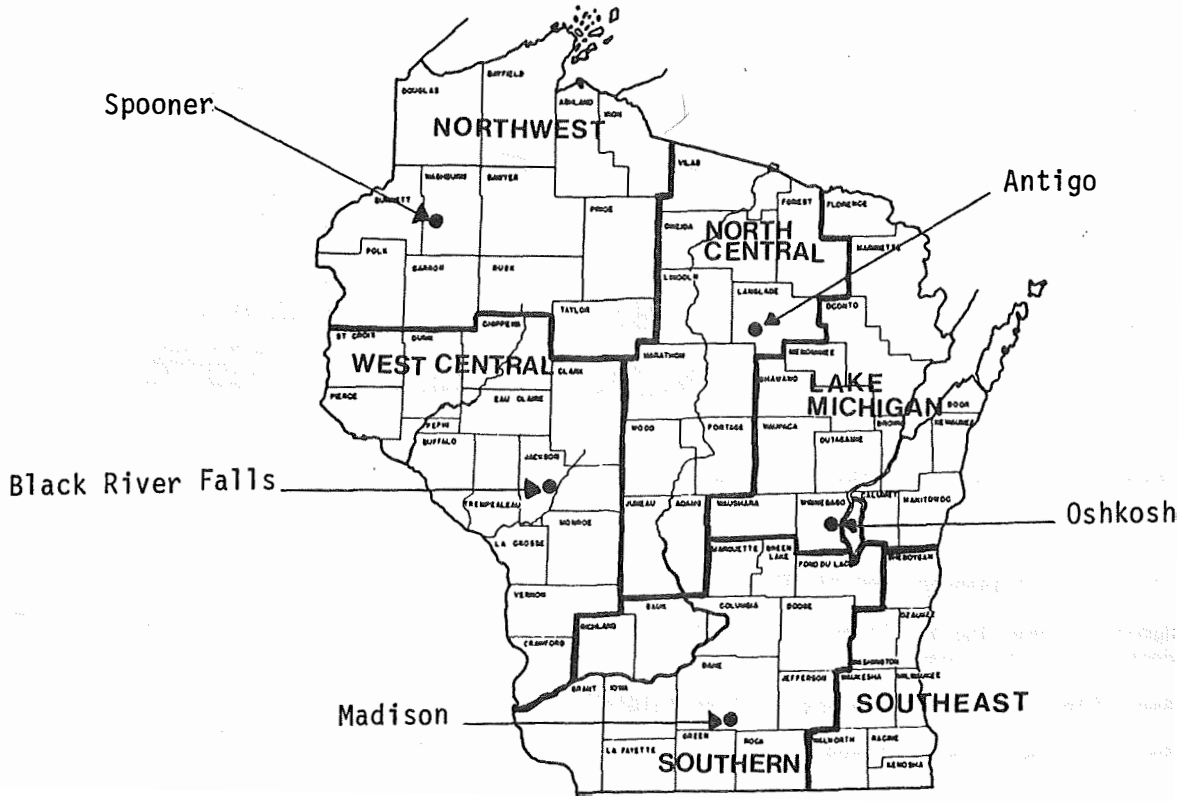

ASPEN

Aspen Bronzing - Unknown

The disease which causes branch and subsequent tree mortality was first observed on large tooth aspen in 1973. (See Forest Pest Conditions in Wisconsin - Annual Reports 1979, 1980) It has been observed in 30-50 locations throughout the state (Figure 1) and may be more widespread than surveys indicate. Its cause is being investigated.

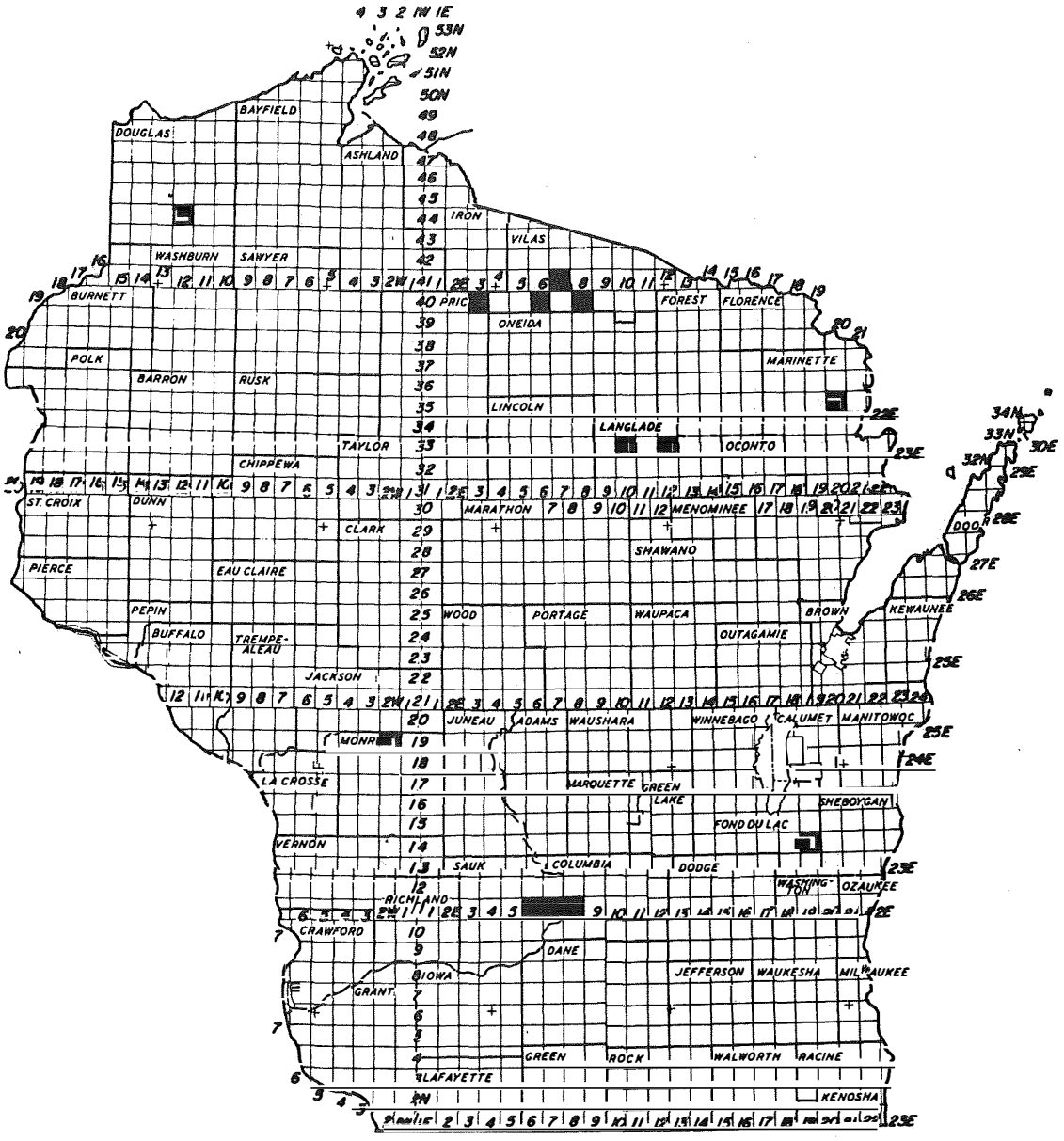

Figure 1. Township locations of Aspen Bronzing in Wisconsin, 1981.

Leaf rust - Melampsora medusae Thum.

Numerous trembling and large tooth aspen were heavily infected in northwestern Wisconsin in 1981 by this conspicuous leaf rust.

Aspen Blotchminer - Phyllonorycter tremuloidiella (Braun)

Severe mining of aspen leaves occurred in Langlade, Forest, Oneida and Vilas counties.

Forest Tent Caterpillar - Malacosoma disstria (Hubner)

The outbreak in the northwestern counties increased in area and intensity so that 1.4 million acres of aspen and oak received moderate to heavy defoliation (Figure 2). Some aspen that has been defoliated for several consecutive years is showing signs of decline.

Migrating larvae caused slippery roads in several places including USH 53 north of Solon Springs and adult moths became a nuisance around lights. White ash trees were defoliated in Minocqua (Oneida Co.).

The numbers of parasitic flies were high and diseased larvae were noticeable at sampling points just north of Solon Springs in Douglas County and between Lake Nelson and the Sawyer - Bayfield County line.

Seven samples of 100 pupae each were examined from these areas in early July. Mortality ranged from 93 to 100 percent. Most of them contained dipterous larvae.

Phenological note:

June 16 - First pupae observed in Douglas County. Larvae showing signs of disease after starting to spin cocoon. Some pupae disintegrating east of Gordon.

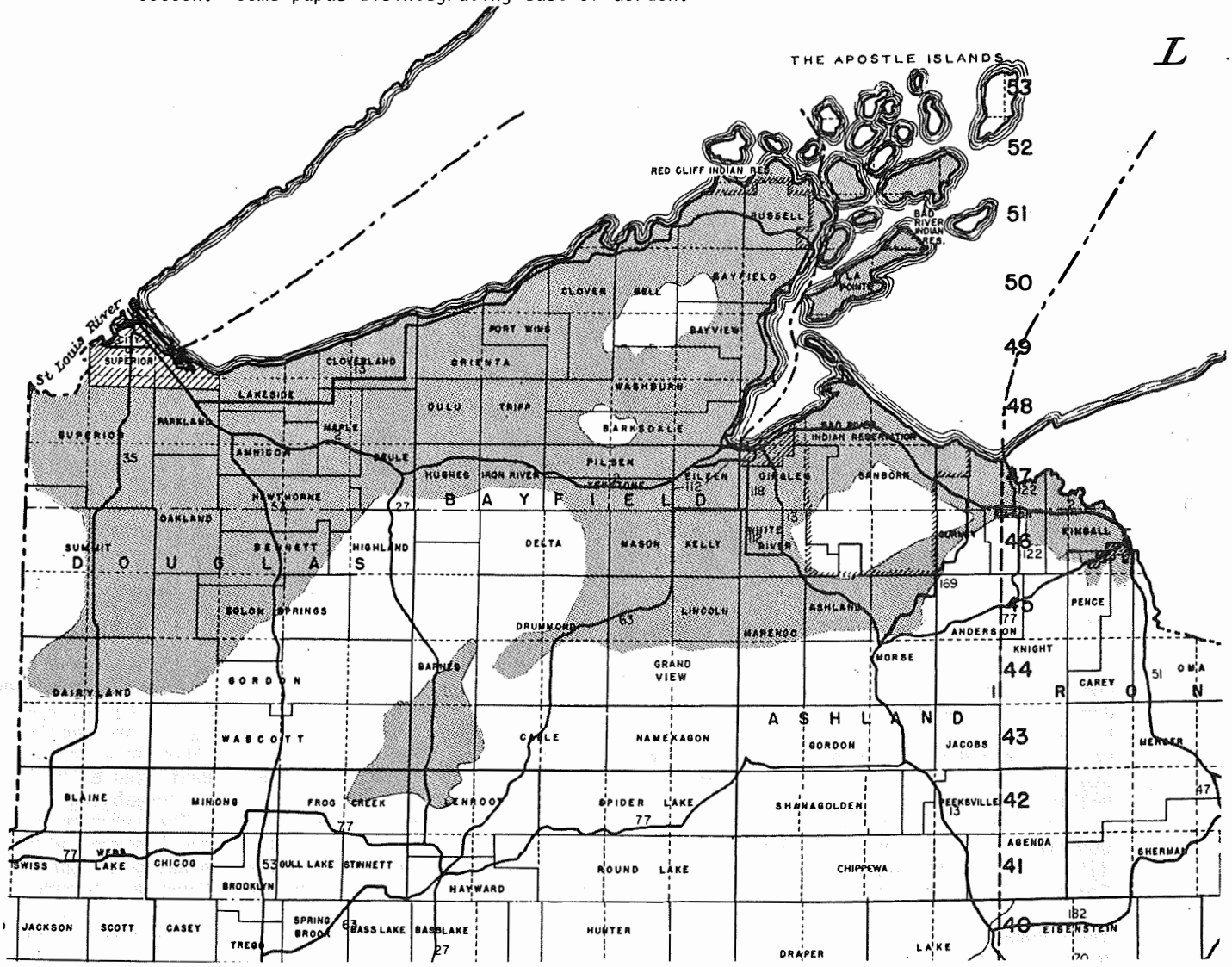

Figure 2. Area of moderate to heavy defoliation by Forest Tent Caterpillar in Wisconsin, 1981.

BALSAM FIR - SPRUCE

Spruce Budworm Choristoneura fumiferana (Clemens)

The outbreak that had covered 180,000 acres of spruce-fir type in the northeastern counties collapsed. The acreage included federal lands. No defoliation was detected during aerial surveys. Early larval counts indicated a drastic decline; larval and pupal parasites were numerous. August egg mass counts (including federal lands) averaged 0.044 egg masses/15 inch branch. Appendix A outlines the history of the outbreak.

In the northwestern counties populations declined so that no defoliation occurred.

Phenology:

May 19 - Second instar larvae observed in Forest County
June 10 - Larvae in 5th instar in Sawyer County
Larvae in 4th and 5th instars in Langlade County
June 17 - About 30% of larvae have pupated in north central counties
June 24 - About 60% of larvae have pupated in north central counties
July 8 - Most of the population is in the adult stage

Balsam Gall Midge - Paradiplosis tumifex (Gagne)

Damage generally increased in the northern counties. Natural stands ranging from reproduction to pole sized trees were heavily attacked in Lincoln, Langlade, Oneida and Shawano Counties. Numerous requests for assistance with control measures were received from Christmas tree growers in Langlade, Lincoln, Oconto, Oneida, Washburn, Sawyer, Price, Marathon and Marinette Counties.

Phenology
May 12 - First observation of ovipositing females in Langlade County
May 19 - Balsam fir buds still tight; adults scarce
May 27 - Gall becoming apparent on balsam needles in Langlade County

Balsam Twig Aphid - Mindarus abietinus (Koch)

Some Christmas tree growers are spraying balsam and Frasier fir with Diazinon to prevent damage.

Spruce Needleminer - Endothenia albolineana (Kearfott)

Heavy infestations were reported in white spruce Christmas trees in Waushara County and Marathon Counties.

BASSWOOD

A Leaf Roller - Sparganothis pettitana Robinson

Two small areas of basswood sawtimber were heavily defoliated on Menominee Tribal Enterprises (Menominee County) land in late May. Basswood trees were completely defoliated in Sections 25 and 36, T29N, R14E. Several trees were marked for detailed observations of events affecting them in 1982.

Basswood Thrips - Sericothrips tiliae (Hood)

For several years pockets of basswood with "frost damage" appeared in scattered locations in Wisconsin. The condition was usually observed in hilly country at elevations of about 1000 ft. or more. Missing and damaged buds and foliage were always limited to basswood. Thrips were suspected as the causal agent after having been found associated with the damage in Dunn County in 1978. This year, adults and immature stages were collected from damaged basswood in Forest County where trees were damaged on 3000 acres around Sugarbush Hill which is in the NE¼ SW¼ Section 36, T36N, R13E. The thrips were identified by Phil Pellitteri, University of Wisconsin Extention Entomologist. Six trees, with damage resembling that observed in other counties, were marked in Forest County for detailed observation in 1982. The symptoms were also observed in Taylor, Rusk and Sawyer Counties where about 1,000 acres of sawlog sized basswood were defoliated; in the Blue Hills of Rusk County where 1,500 acres were defoliated; in Weirgor Township in Sawyer County where 200 acres were defoliated; and in Oconto, La Crosse and Door Counties (Figure 3).

The damaged trees refoliated by early August but the new leaves remained smaller and lighter in color than normal foliage.

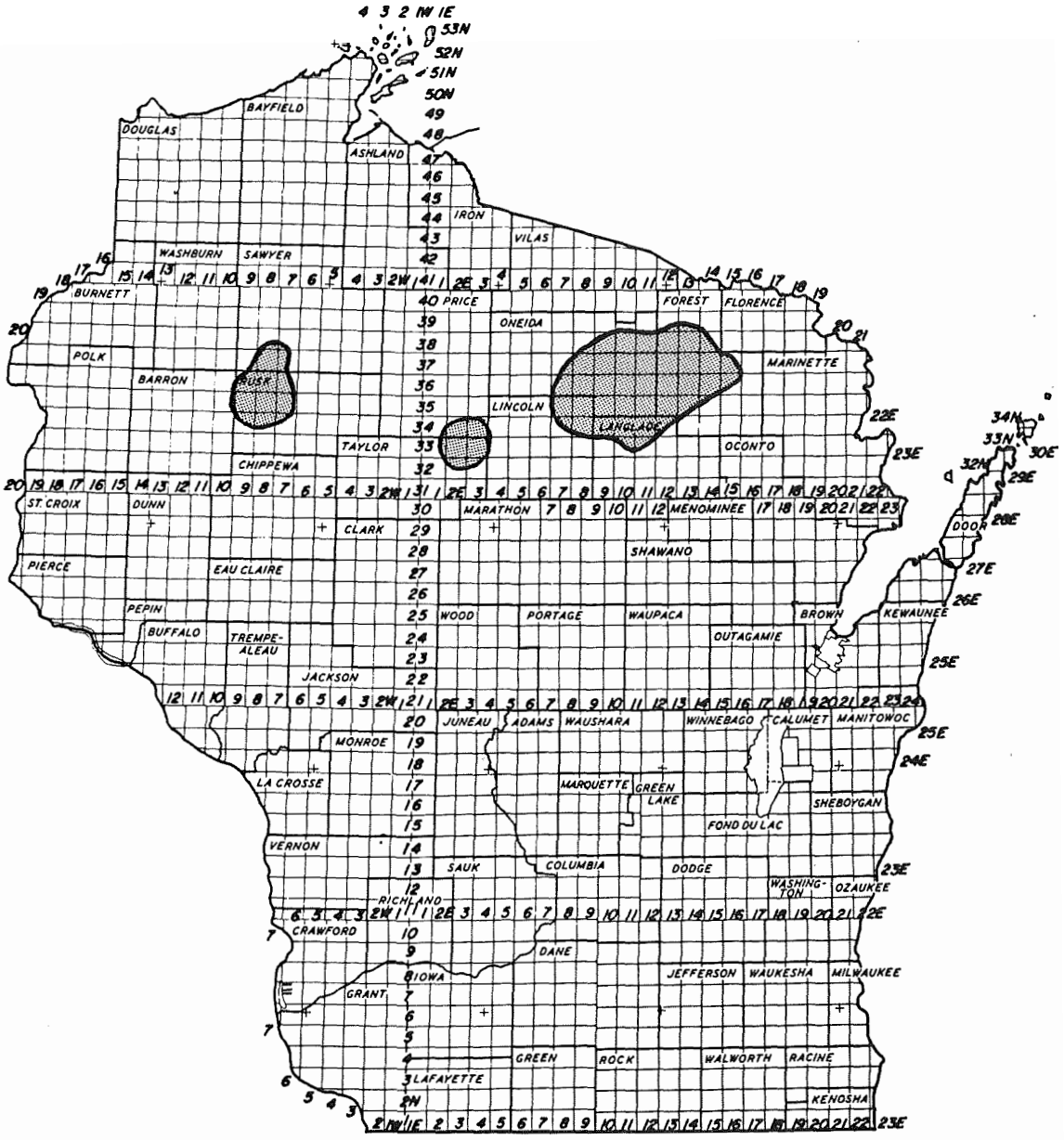

Figure 3. Location of moderate to heavy defoliation by Basswood Thrips in Wisconsin, 1981.

BIRCH

Birch Leafminer - Fenusa pusilla (Lepeletier)

Damage to forest trees that had been common in Northern Wisconsin for several years was rare in 1981.

Birch Skeletonizer - Bucculatrix canadensisella (Chambers)

Pockets of heavy defoliation occurred in scattered locations over most of Wisconsin. In the southwestern counties, symptoms were often confused by the presence of heavy Septoria leaf spot damage. The larvae avoided the leaves with leaf spot damage and often completely skeletonized the remaining foliage.

BUTTERNUT

Butternut canker - Siroccoccus sp.

In some SW Wisconsin plots over 80% of butternuts were cankered and 32% of the cankered trees were dead. The disease is now in 20 counties (Figure 4) and has been reported throughout eastern U.S.

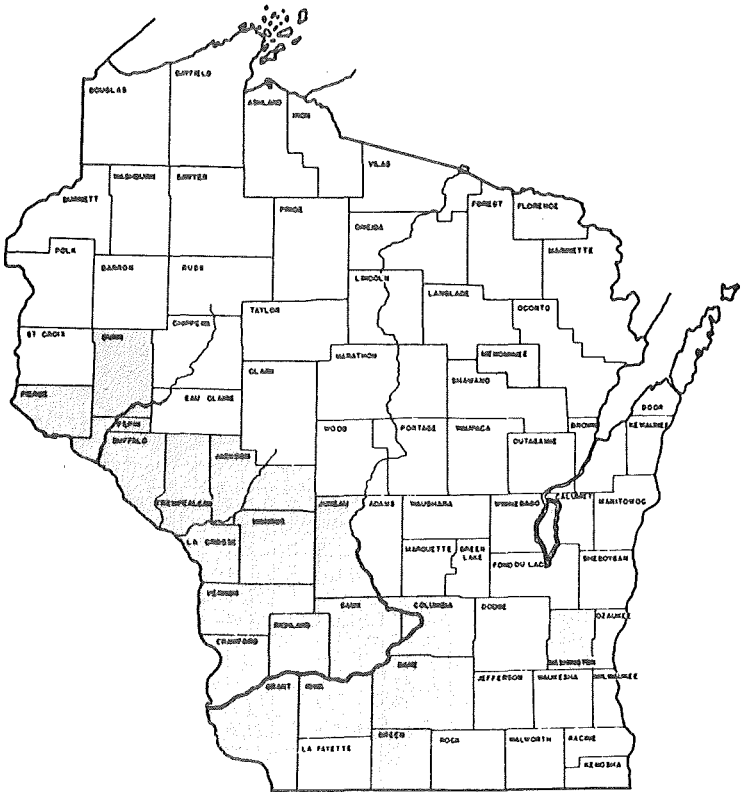

Figure 4. County distribution of Butternut Canker in Wisconsin, 1981.

CHERRY

Eastern Tent Caterpillar - Malacosoma americanum (Hubner)

Populations were again generally high in the Southern one-fourth of Wisconsin. Scattered pockets of tents were observed in some northwestern counties.

Cherry Scallop Shell Moth - Hydria prunivorata (Ferguson)

A pocket of heavy defoliation of black cherry occurred in central Washburn County (T39N, R11W). Pockets of severe defoliation occurred in Wood and Portage counties. Other species of Prunus were untouched. Larva were still feeding in Washburn County on July 28, but had finished feeding in Wood and Portage counties.

ELM

Dutch Elm Disease - Ceratocystis ulmi (Buisman) Moreau

Dutch elm disease was first reported in Wisconsin in 1956. By 1978, about 50% of the elms were alive as the disease moved upstate rapidly along the waterways, in raw wood products and by other means. In 1981 an estimated 80-90% of the pole-size and larger elms throughout Wisconsin were infected with DED. About 500 million cubic feet of elm died from the disease between 1968 and 1978; approximately 200 million cubic feet were utilized.

In 1981, 17 Wisconsin communities participated in a $83,000 Dutch elm disease control demonstration program that was sponsored by the U.S.D.A. Forest Service. This program in its fourth year is utilizing all major known control measures including survey, injection, root graft control and sanitation. More than 585 cords of elm firewood and 4,075 cubic yards of chips were produced from diseased elms within the demonstration communities.

Smaller European Elm Bark Beetle - Scolytus multistriatus (Marsh.)

The continuing survey by Wisconsin Department of Agriculture added two new counties, Polk (near Osceola) and Oneida (near Pelican Lake), to the known range of this DED vector. (Figure 5).

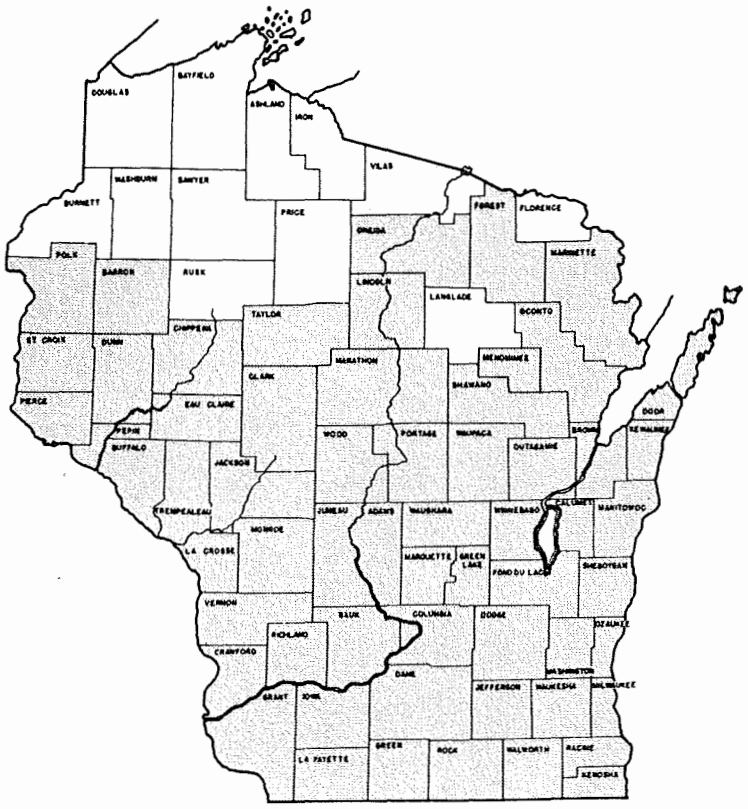

Figure 5. County distribution of Smaller European Elm Bark Beetle in Wisconsin, 1981.

HEMLOCK

Hemlock Mortality

Hemlock mortality on the Menominee Tribal Enterprises Forest has been increasing since the drought of 1976-77. Approximately 4.5 million board feet died in 1980-81. Root rot (Armillariella mellea) and hemlock borer (Melanophila fulvoguttata) are found in association with the dying trees. Trees of all ages are affected.

LARCH

Larch Sawfly - Pristiphora erichsonii (Hartig)

Scattered patches of severe defoliation occurred in Langlade and eastern Oneida Counties. Light defoliation was observed in Bayfield County.

Larch Needlecast - Mycosphaerella laricina (Hartig)

Mycosphaerella needlecast of European larch was first reported in North America in 1980 from larch plantations planted between 1966 and 1968 in LaCrosse and Trempealeau counties. Surveys in 1981 revealed a 10-acre infected plantation in Polk County, a windbreak at Wyalusing State Park and a European larch seedbed at Wilson State Nursery, Boscobel, Wisconsin (Table 1).

TABLE 1. Know Locations of Larch Needlecast (Mycosphaerella laricina Hartig) in Wisconsin-1981.

County	Location	Age (years)	Acres
Grant	NW, NW, Sec 29 T6N, R6W	10	3
	Wilson State Nursery, Boscobel (Seed beds & one specimen tree)	1-0	
La Crosse	NENE, Sec 9 T17N, R6W	11	4
	T16N, RSW, SENW, Sec 9	7	5
	NWSE, NESE, Sec 11 T17N, R6W	8	12
	Sec 11 T17N, R6W	10	4
	SWSE Sec 18 T16N, R5W	19	25
	NWSW Sec 19 T16N, R5W	19	
Trempealeau	SWNW Sec 33 T23N R9W	11	1-6
Polk	SWSE, Sec 32 T37N, R15W	10	10

MAPLE

Maple Decline

Detection and appraisal surveys, including computerized tree inventories, show that urban maples (not woodland maples), especially sugar maples of all ages, sizes, and locations suffer dieback, decline, and death. Basal trunk canker incited by Fusarium sp. and collar and root rot incited by Phytophthora citricola are common components of the disease. Reinnoculations performed by University of Wisconsin plant pathologists have proved their pathogenicity.

Maple Trumpet Skeletonizer - Epinotia aceriella (Clemens)

Populations continued to increase in the northern half of Wisconsin. Light defoliation of sugar maple was noticeable over a large area (Figure 6). About 100,000 acres of heavy defoliation occurred in Ashland, Forest, Oneida and Langlade Counties. Light defoliation was observed in Oconto and Outagamie Counties.

Orangehumped Mapleworm - Symmerista leucitys (Franclemont)

Numbers of this late summer defoliator continued to increase in Forest, Oneida, Vilas, Langlade, Iron and Ashland counties. About 3,000 acres of severe defoliation were reported (Figure 7). Two infestations were first observed in Vilas County in late August. One was on the northeast side of Big Arbor Vitae Lake in Section 20, T40N, R7E and the other about 6 miles northwest of Boulder Junction in Section 20, T43N, R7E. Larvae were nearly full-grown by September 19. This insect was responsible for partial to complete defoliation of scattered sugar maple stands from Langlade County to Douglas County in 1961 and 1962.

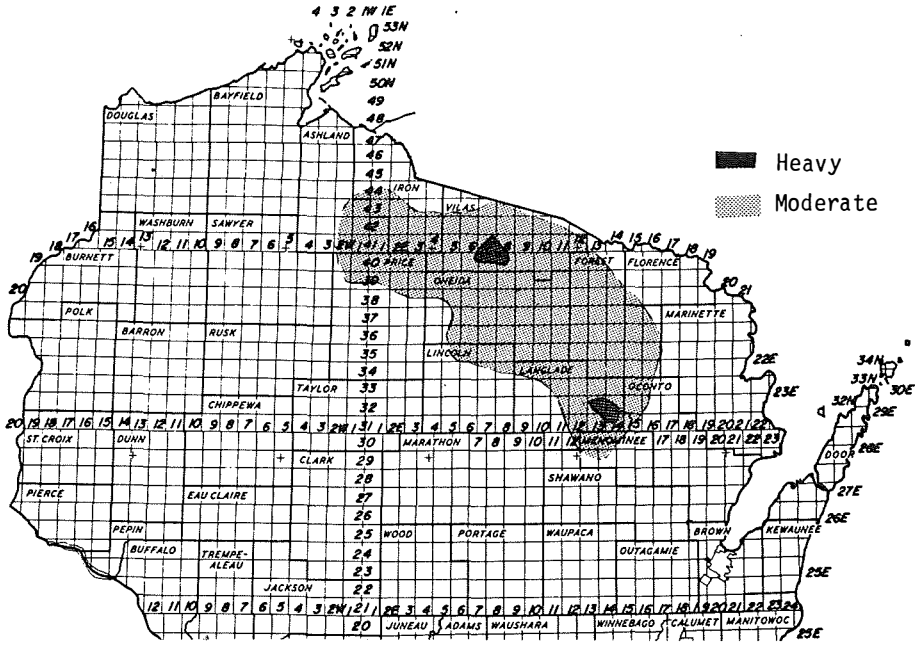

Figure 6. Area of defoliation by the Maple Trumpet Skeletonizer in Wisconsin, 1981.

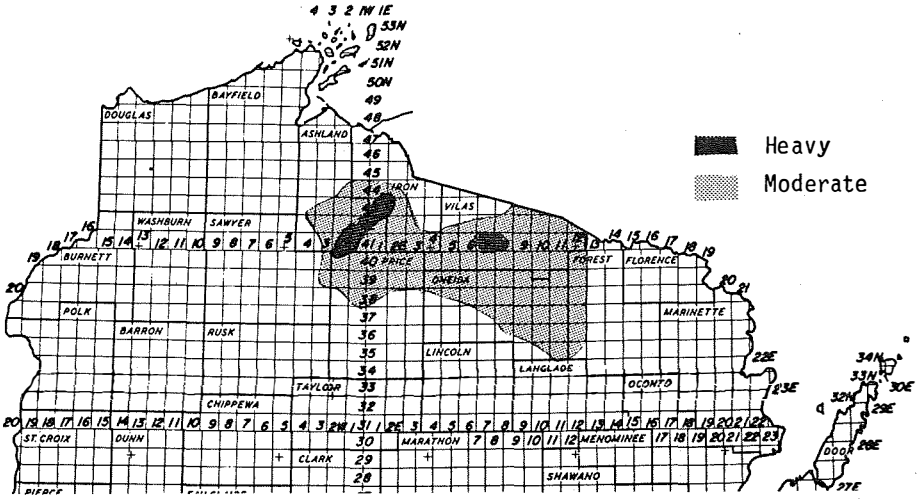

Figure 7. Area of defoliation by the Orangehumped Mapleworm in Wisconsin, 1981.

Lecanium scale - Lecanium sp.

A heavy infestation was observed on more than 200 acres of mature sugar maples in Forest County on industrial forest land. Mature females were heavily attacked by a fungus disease. The accumulation of sooty mold on branches and tree trunks indicated the infestation had been present for some time. Sawyers working on industrial land in Section 4, T35N, R15E reported two infestations which were observed in the section in 1980.

Cottony Maple Scale - Pulvinaria innumerabilis (Rathvon)

Pockets of heavy populations remained in several southeastern counties on ornamental and forest silver maple. The twice stabbed lady beetle was reported feeding on crawlers in Kenosha County in mid June.

OAK

Oak Wilt - Cerctocystis fagacearum (Bretz) Hunt

There were few reports of new infection centers but existing pockets did continue to enlarge via root grafts. No new counties with oak wilt infections were reported in 1981 (Figure 8). The European Economic Community (EEC) accepts logs and other wood from known oak wilt free areas in the state, but not from counties where the disease is known to be present. Lumber and processed products from infected counties may be shipped, provided meet conditions stipulated by the participating countries are met.

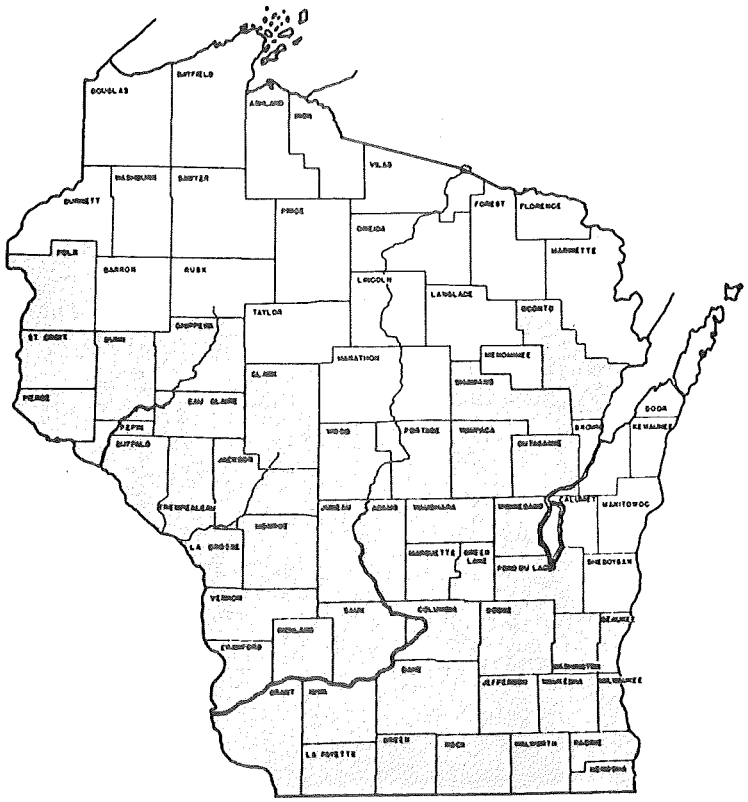

Figure 8. County distribution of Oak Wilt in Wisconsin, 1981.

Eastern Gall Rust - Cronartium quercuum f. sp. banksianae

Extremely heavy infections occurred on northern pin oak and white oak in northwestern Wisconsin this year. Leaves turned brown, curled up and dropped prematurely on some trees.

Oak Webworm - Archips fervidanus (Clemens)

Bur oak was heavily infested in Douglas, Burnett and Washburn Counties. Little damage resulted but the unsightly nests were conspicuous especially in oak sprouts in burned over areas.

Spring Defoliator Complex

Scattered pockets of black oak were heavily defoliated by a complex of spring defoliators in Dane, Iowa, Sauk and Columbia Counties. None were reared to the adult stage so positive identification was not possible. Two species of Tortricidae, and one Acleris sp. were collected.

Bur and white oaks suffered varying degrees of defoliation in the southern half of the state. Cutworms, cankerworms and leaf rolling tortricids were observed.

Walkingstick - Diapheromera femorata (Say)

An infestation caused noticeable defoliation in 200 acres of oak on the boundary of Jackson and Clark counties (T23N, R1W, S1 and T23N, R1E, S6). This area had a similar heavy outbreak in 1979. Walkingsticks were a nuisance to rural residents in other areas of Clark, Eau Claire and Jackson Counties. Noticeable numbers of walkingsticks were observed in Oconto and Green counties.

PINE

Pine Wood Nematode - Bursaphelenchus xylophilus (Steiner and Buhrer)

This native nematode has been taken from dead conifers in 21 counties (Figure 9). Known host species in Wisconsin are red, jack, scotch, Austrian, ponderosa and white pines and European larch.

A field test is in progress in Sauk county testing the effectiveness of sanitation in limiting the spread of pockets of red pine mortality. About five cords of dead red pine were removed from one of two pockets of mortality in April. A few trees died in both the treated and untreated pockets in September but the numbers were drastically reduced from 1980 levels. Sanitation, if it is to be effective, may require several years of treatments.

A cooperative study is in progress with the Department of Plant Pathology, University of Minnesota and the North Central Forest Experiment Station USDA - Forest Service which involves vector effectiveness, effects of tree stress on nematode invasion and host species susceptibility.

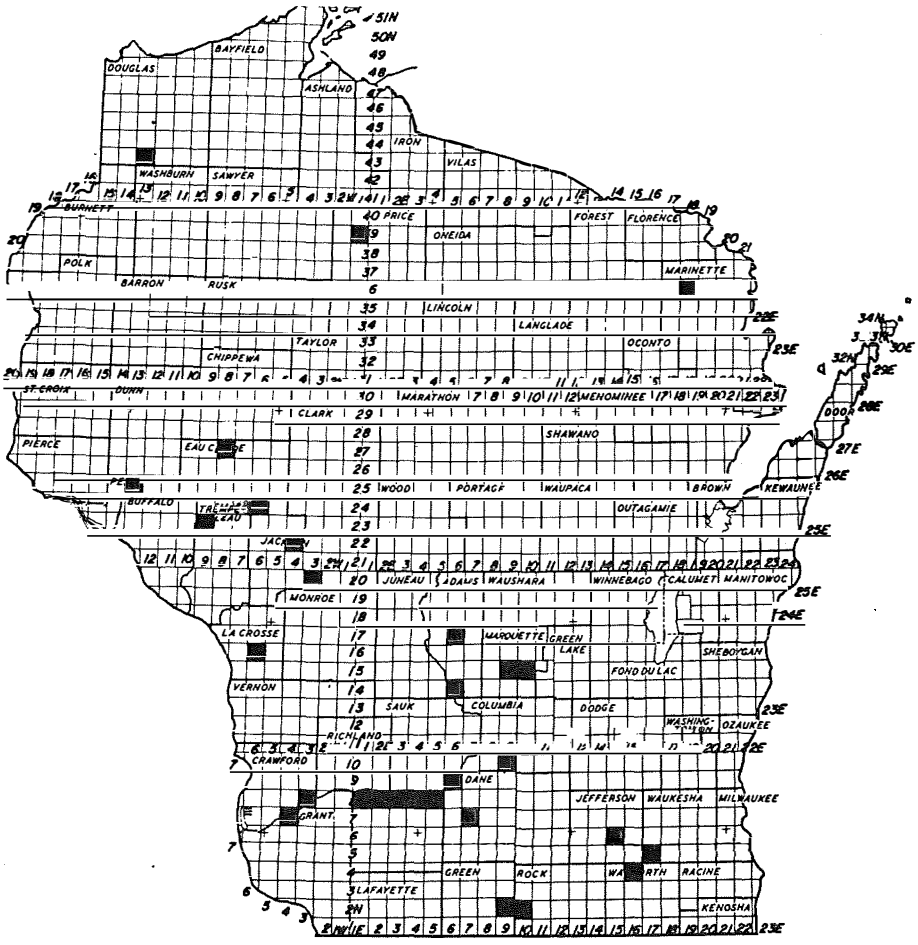

Figure 9. Known township locations of Pine Wood Nematode in Wisconsin, 1981.

Scleroderris Canker - Gremmeniella abietina (Lagerb.)

Nine red pine plantations are known to be infected on state and private lands in Wisconsin (four in Bayfield County and five in Vilas County). There are additional plantations infected on national forest lands in northern Wisconsin. Up to 1981, 11 counties had reported presence of Scleroderris (Figure 10). Annual surveys since 1978 have revealed no new infected plantations on state or private lands. There was no additional mortality from Scleroderris in previously infected plantations. In fact, it was difficult to find infected trees in some of the previously infected plantations.

Red Pine Shoot Blight - Sirococcus strobilinus (Pruess)

Significant losses of understory red pine seedlings and saplings occurred in Vilas and Oneida Counties in previously infested areas. Two new locations were recorded in 1981 on the Northern Highland State Forest in Vilas County. County distribution of reported presence of red pine shoot blight is shown in Figure 11.

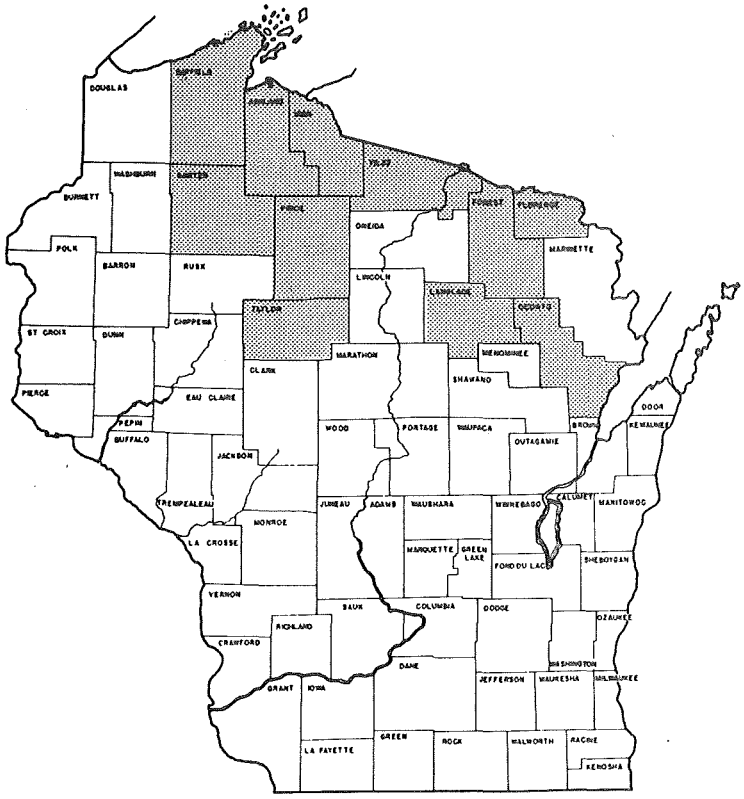

Figure 10. Known county distribution of Scleroderris Canker in Wisconsin, 1981.

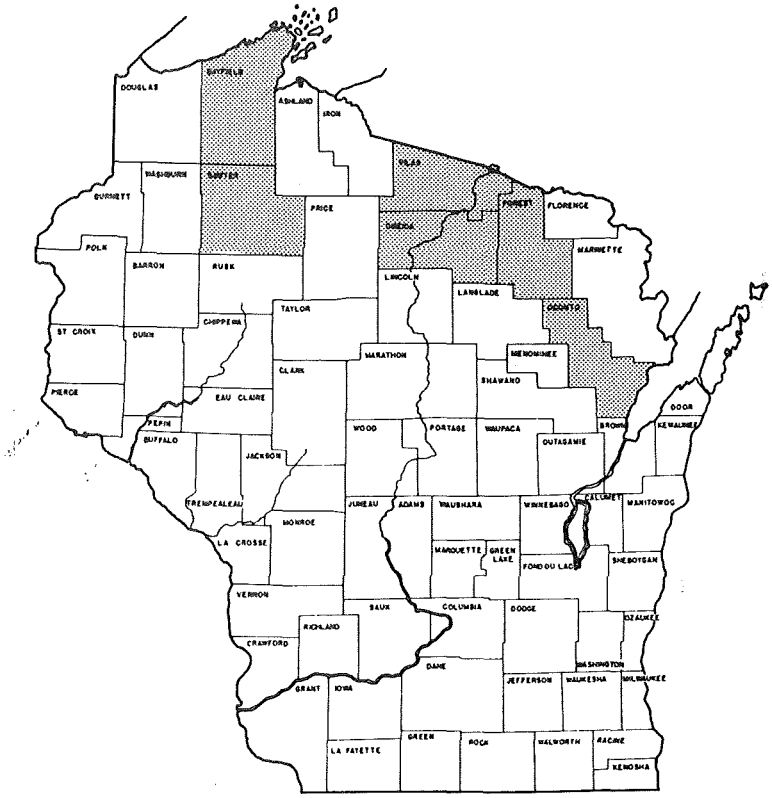

Figure 11. Known county distribution of Red Pine Shoot Blight in Wisconsin, 1981.

European Pine Sawfly - Neodiprion sertifer (Geoffroy)

This spring defoliator increased its area of infestation slightly so that about 1,600 acres of red pine suffered light to heavy defoliation (Figure 12). Overwintering egg numbers had indicated a large increase in the severity of defoliation in Walworth and Waukesha Counties. A period of cold windy weather after egg hatch wiped out many colonies and reduced the size of other colonies. The resulting defoliation was not as severe as expected in many places although some red pine plantations were completely stripped of old foliage.

Several locations were innoculated with the nucleopolyhedrous virus (NPV) in 1980. The virus remained active in these locations in 1981 and increased the area of infection (Figure 13). It did not prevent heavy defoliation adjacent to the infected pockets.

More locations were innoculated with NPV in 1981. Paper grocery bags were filled with red pine branches containing 10-12 NPV contaminated colonies of sawflys. These bags and instructions were given to landowners who wanted to innoculate sawfly populations on their lands.

A cooperative field experiment was conducted with USFS to test the ability of a spray formulation of NPV to prevent defoliation (SE¼ Sec 18, SW½ Sec 17, T4N, R17E). The test was successful; a publication is in preparation.

The Ichneumonid parasite Lophyroplectus oblongopunctatus, which was released in Walworth County in 1977 continued to increase its numbers (Figure 14). Samples of sawfly larvae (500 - 2000 larvae per sample) collected in 1980 produced from 19.5% L. oblongopunctatus at the original release location to 4.5% 330 yards away. Another 20,000 larvae were collected in 1981 for releases of emerging parasites in 1982.

A field experiment conducted in Waukesha County (NWSW Sec 31, T6N, R17E and NWSE Sec 32, T5N, R18E) with the cooperation of University of Wisconsin, Department of Entomology and USFS - Northeast Forest Experiment Station tested the ability of NPV - contaminated L. oblongopunctatus to innoculate a population with the virus. The experiment demonstrated that the adult parasites can effectively transmit the virus into sawfly populations. Detailed results are in Mohamed, M.A., et. al 1982. Field release of virus-sprayed adult parasitoids of the European pine sawfly in Wisconsin. Great Lakes Entomologist 14:177-178.

Red Pine Sawfly - Neodiprion nanulus nanulus (Schedl)

Populations and defoliation increased in Sauk, Columbia, Marquette and Green Lake Counties where about 550 acres of pole sized red pine were defoliated.

Jack Pine Sawfly - Neodiprion pratti banksianae (Rohwer)

Larvae were noticeable in some locations in Burnett and Washburn Counties.

Redheaded Pine Sawfly Neodiprion lecontei (Fitch)

Populations increased in the northeastern counties. In Langlade County, where large numbers of eggs failed to hatch, defoliation was light. In Forest County, a 100-acre young red pine plantation was treated with malathion to prevent heavy defoliation. Occasional colonies were observed in several central and northern counties.

Introduced Pine Sawfly - Diprion similis (Hartig)

Populations remained very low. No reports of defoliation were received.

White Pine Sawfly - Neodiprion pinetum (Norton)

Populations continued very low. Reports of defoliation were received from Grant and Jefferson Counties.

Jack Pine Budworm - Choristoneura pinus (Freeman)

The infestation in Douglas and Bayfield Counties increased in size to cover about 140,000 acres of pole-sized jack pine. Light to moderate defoliation prevails over most of the area; a few pockets of heavy defoliation were observed. No tree mortality was attributed to this infestation.

Larvae were generally present in other jack pine areas. Minor defoliation of sapling jack pine was observed in southern Sauk County and in Jackson County.

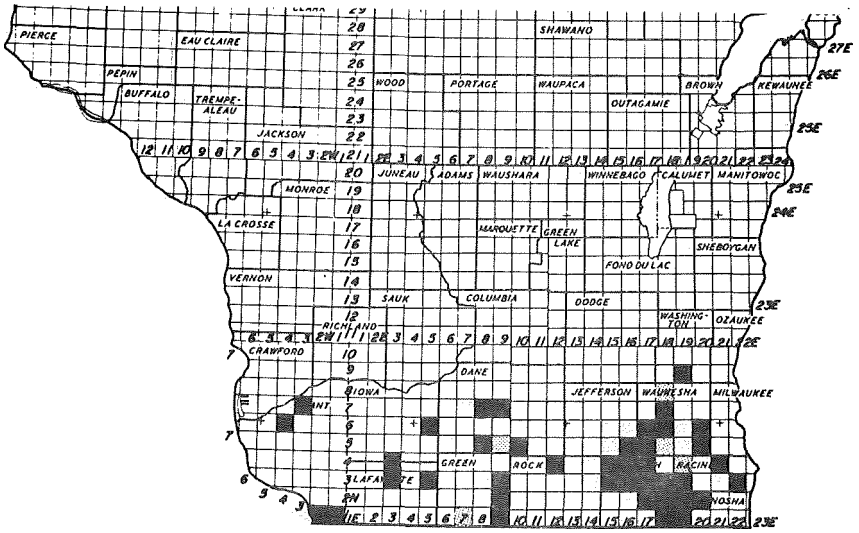

Figure 12. Area of European Pine Sawfly infestation, 1972-1980 (solid), new area of infestation in 1981 (dotted).

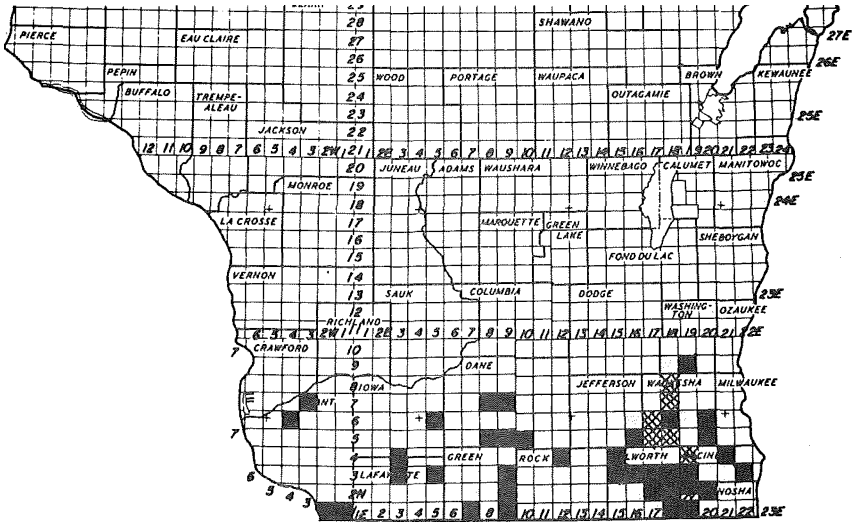

Figure 13. Known areas of European Pine Sawfly infestation from 1972-1981 (solid), and areas where the nucleoplyhedrous virus was present in 1981 (cross hatched).

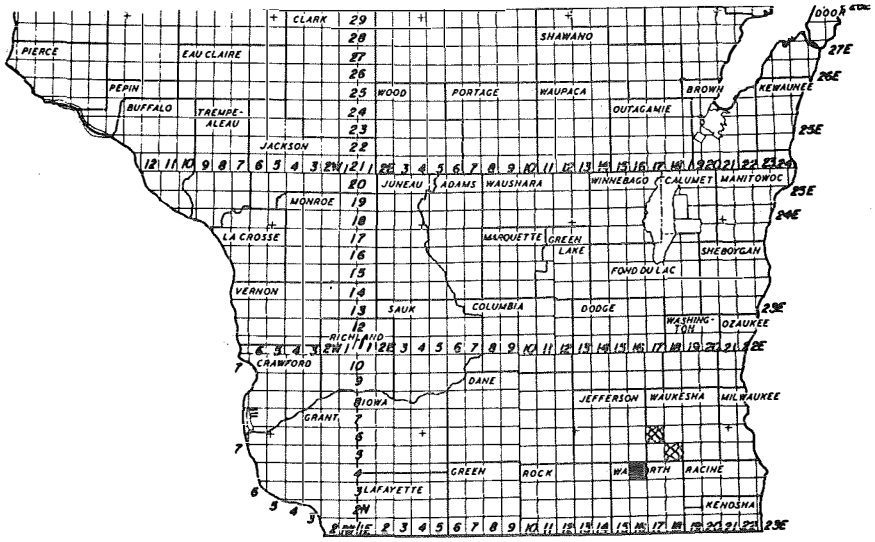

Figure 14. Original release site of Lophyroplectus oblongopunctatus in 1977 (solid), and recolonization sites in 1981 (cross hatched).

Pine Tussock Moth Dasychira pinnicola (Dyar)

The outbreak of this spring defoliator increased in area and severity so that it covers 40,000 acres of red and jack pine in Douglas and Bayfield Counties (Figure 15). Defoliation was light to moderate on 80% of the infestation and heavy to severe on the remainder. Jack pine has been most severely defoliated to date in this outbreak. About 10,000 acres of jack pine has scattered mortality and topkill. No extensive areas of complete tree mortality have occurred.

Some eye and skin irritation were experienced by workers within the outbreak area during the pupation period; this was probably caused by the hair dropping from cast larval skins.

A few Calosoma beetles were observed feeding on the caterpillars, but the predators and parasites are too scarce to have great effect on 1982 caterpillar numbers which were extremely high going into the winter. The 1982 larval density is expected to be double the 1981 level and the area of outbreak should increase by 50% to 60,000 acres.

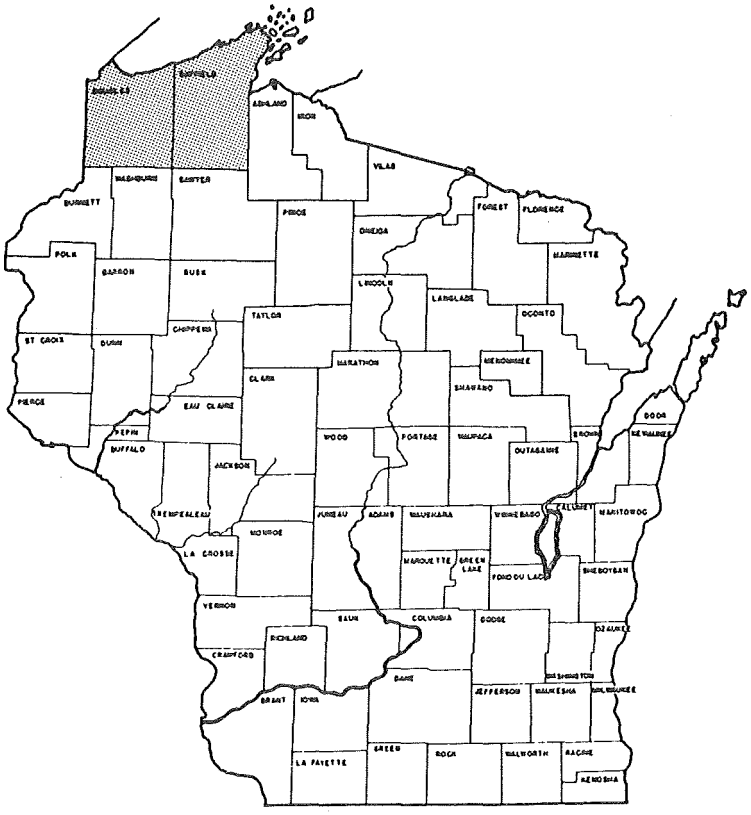

Figure 15. County distribution of defoliation by Pine Tussock Moth in Wisconsin, 1981.

Red Pine Needle Midge - Thecodiplosis piniresinosae (Kearby)

Needle browning caused by this midge was evident in many pole-sized red pine stands throughout Wisconsin in September and October. Defoliation was generally reduced by 50-90% from 1980 levels although all levels could be found. Plantations that have been heavily attacked for several consecutive years are showing signs of stress. Terminal growth in 1981 was reduced by 25 - 50% in plantations severely defoliated in 1980. Some terminal leader mortality resulted from 1980 attack in a few stands in Dunn, Jackson, Monroe and Trempealeau Counties.

A Needle Midge - probably Contarinia sp.

A condition of current year needles of 15 - 25 ft. planted red pine became evident in Juneau, Lincoln, Shawano and Vilas Counties in late July and August. Symptoms were: needle browning; drooping at the base of the needle sheath of green and brown needles; dropping of green and brown needles.

Severe browning of the top 3 to 5 feet occurred in Shawano County. A few dead midge larvae, probably Contarinia sp. were found in the needle bases. It appeared that in most of the needles, the larvae died early in development and could not be identified as insects. Severe drought in June and July in this area may have contributed to the symptoms and mortality of the midge larvae.

A Pine Pitch Midge - Cecidomyia reeksi (Vockeroth)

Brown flags were common in jack pine in Douglas and Bayfield County. Individual open-grown trees were heavily attacked.

A Leaf Beetle Cryptocephalus sp.

Browning of red pine needles in a seed orchard in Iowa County in September, was initially believed to be caused by red pine needle midge. Close inspection revealed that the edges of the needles had been nibbled in areas extending up to an inch along the length of the needle. The needles turned brown beyond the area of feeding. Most of the feeding attacks were near the bases of the needles. The adult beetles, Cryptocephalus sp., were found mating and resting on the buds, twigs and needle bases on September 18. Adults were identified by University of Wisconsin Extension Entomologist, Phil Pelletteri. The damage was concentrated along the south edge of the seed orchard adjacent to a weedy cultivated area; it is assumed that the immature stages are leaf feeders on these weeds.

Zimmerman Pine Moth - Dioryctria zimmermani (Grote)

The outbreak continued in red pine plantations in parts of central and southern Wisconsin (Figure 16). In Jackson and Monroe counties, where numbers of attacked red pine shoots have been very high for several years, numbers declined slightly.

In the southwestern counties, numbers of attacked shoots increased but parasitism of large larvae was extremely high and numbers are expected to be reduced in 1982.

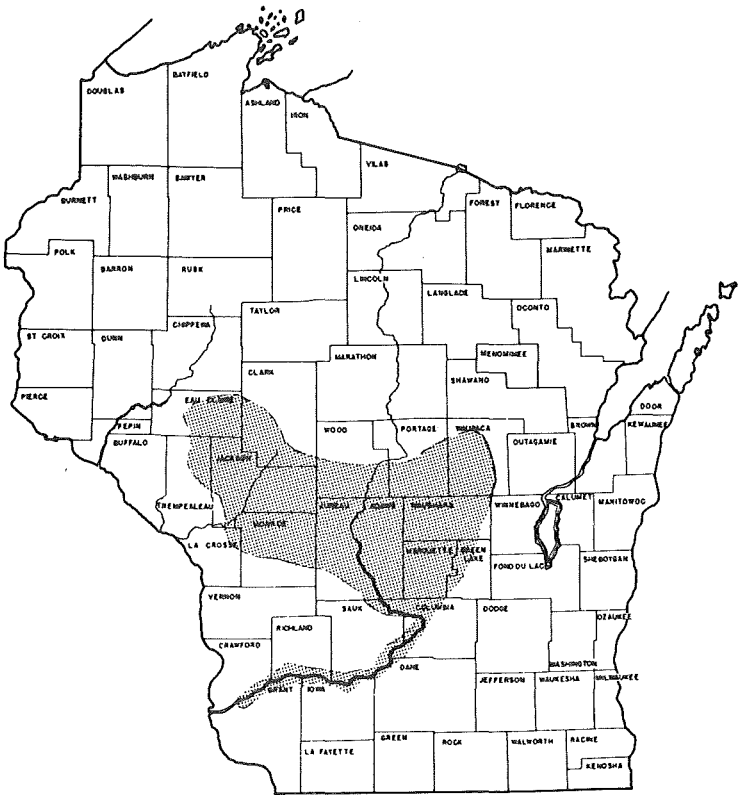

Figure 16. Locations of Zimmerman Pine Moth in Wisconsin, 1981.

Saratoga Spittlebug - Aphrophora saratogensis (Fitch)

There was a general decline in numbers in the north central and northeastern counties where this species is common; however, flagging on isolated sapling red pine was observed in a single plantation in Douglas County.

Two thousand acres of suceptible-age planted red pine were surveyed in Langlade and Oneida Counties; none required treatment.

Pine Spittlebug - Aphrophora parallela (Say)

Numbers of spittle masses increased slightly in the central and northern counties. Many were reported in Douglas and Marathon Counties on balsam fir, scotch pine, jack pine and white pine. No serious injury was reported on infested hosts.

White Pine Aphid - Cinara strobi (Fitch)

Aphids were abundant locally in several south central counties. Several infestations on pole and sawlog size white pines were nearly eliminated by lady beetles. Several landowners in Dane County wanted to know what to spray on "all those white bugs" which were lady beetle pupae.

Pine Bark Adelgid Pineus strobi (Hartig)

Populations on pole-sized white pine in the central and southern counties declined slightly although heavy populations could still be found. Pupae of a small syrphid predator were found on the bark with the adelgids; we were not able to rear any of the syrphids to the adult stage.

Heavy infestations in two-year old white pine at the forest nurseries at Boscobel and Wisconsin Rapids was associated with stunted growth and caused light mortality. Preliminary tests of the phytotoxicity and efficacy of Di-Syston on 2-0 and 3-0 seedlings were initiated at Boscobel. Evaluation is incomplete.

Pine Needle Scale - Chionaspis pinifoliae (Fitch)

An extremely heavy infestation turned the lower branches white on a few sawlog sized white pine in Sauk County.

Black Pineleaf Scale - Nuculaspis californica (Coleman)

Scales were noticed occasionally on red pine in the southern counties. One or two scales per needle were observed in pockets in a red pine seed orchard in Iowa County.

Pine Root Collar Weevil - Hylobius radicis (Buchanan)

Levels of tree mortality remained at about 1980 levels in most areas. A heavy infestation killed several red pines in the seed orchard near Avoca in Iowa County (T8N, R1E, Sec. 10).

Pine Root Tip Weevil - Hylobius rhizophagus (Millers)

Flagging of red pine continued in the central sands counties where volunteer jack pine is intermixed in the planted red pine. Levels of infestation were not substantially different from 1980 levels.

White Pine Weevil - Pissodes strobi (Peck)

Damage to White and Jack Pine continued at about 1980 levels in most areas; some increase was noted in Jackson County.

Northern Pine Weevil - Pissodes approximatus (Hopkins)

Damage was again very low in most areas. Heavy damage to newly planted Austrian pine Christmas trees was reported in Walworth County.

Pine Bark Beetles - Ips sp.

Red pine mortality was substantially reduced in 1981. Adult Ips grandicollis (Eichhoff) were collected from dead and dying pole-sized red pine in Iowa and Sauk Counties where the pine wood nematode is known to be present.

White Grubs - Phyllophaga sp.

About 30% of an 80 acre spring planting of containerized red pine seedlings in Washburn County were killed by white grubs. Some of the mortality occurred in pockets; some as scattered individuals. Another 20% of the seedlings died from unknown reasons.

BLACK WALNUT

Walnut Anthracnose - Gnomonia leptostyla (Fr.) Ces. & deNot.

An extended period of very rainy weather in August caused extremely heavy early defoliation in the southwestern counties. By mid September, few leaves remained on black walnut trees. An occasional individual tree was found that was completely unaffected by the disease.

Black Walnut Canker and Dieback

Recently, a vertical, elongate, and sometimes girdling stem canker has severely damaged and even killed young walnuts in plantations. A Fusarium sp. has been isolated repeatedly and has induced cankers on stem-inoculated walnut seedlings and saplings. Investigation of this stem canker has been complicated by a collar rot, branch cankers associated with Phomopsis sp., and twig dieback associated with Phyllosticta sp. Current research at the University of Wisconsin seeks to clarify the significance and relative roles of these different fungus pathogens.

Walnut Caterpillar - Datana integerrima (Grote)

Locally heavy defoliation of black walnut occurred in several southeastern counties.

Pecan Leaf Casebearer - Acrobasis juglandis (LeBaron)

After several years of low densities, this bud destroyer is increasing in numbers in southwestern Wisconsin.

A preliminary test of the efficacy of malathion and Bacillus thuringiensis Berliner to kill the small larvae on the leaves was applied September 11. Malathion significantly reduced the number of overwintering hibernaculae; B.T. did not. Several problems arose during the evaluation on September 18. Differentiating between a live larva and a "sick" one in the field, with a hand lens, is not reliable. Adult A. juglandis were apparently still active in mid September because new larvae appeared after the individual branches were sprayed. Anthracnose caused substantial leaf drop during the test. Most of the trees were completely yellow or completely defoliated when the test was evaluated. Occasional green trees which were not affected by anthracnose acted like magnets to late season adults which oviposited heavily on them.

MISCELLANEOUS SPECIES

Whitemarked Tussock Moth - Orgyia leucostigma (J. E. Smith)

This tussock moth caused significant defoliation on elm, basswood, sugar maple and understory shrubs in an area of eastern Ashland County that was heavily defoliated by orangehumped mapleworm.

Gypsy Moth - Lymantria dispar (L.)

An infestation that was detected in Appleton in 1975 has been declared eradicated after no moths were trapped in 1980 and 1981. High intensity trapping at 3 (+) disparlure-baited traps per acre was the only treatment conducted in the area.

The infestation between Oconomowoc and Okauchee Lakes continues. Three small pockets were sprayed with hydraulic application of Sevin XLR. Two of these areas were sprayed with a helicopter application of disparlure in plastic chips; no moths were caught. The third area was trapped with three (+) disparlure-baited traps per acre; 69 male moths were caught inside this area and 5 were caught just outside it and one egg mass was found.

A new infestation was detected in the city of Monona where 236 male moths were caught and two egg masses were found.

A new infestation was detected in Delavan where 14 male moths were trapped and one egg mass was found.

Fall Cankerworm - Alsophila pometaria (Harris)

The population persisted in sufficient numbers to cause noticeable defoliation of a few black oak in Walworth and Waukesha Counties. Spring and fall cankerowrms defoliated large numbers of boxelder on the Brown County Wildlife refuge.

Shoot Blight - Sphaeropsis ellisii Sacc.

This fungus caused significant damage to current year's shoots in Colorado blue spruce windbreaks in Langlade County and Christmas trees in Adams County.

NURSERY PROBLEMS

Scotch Pine Needlecast - Lophodermium pinastri (Schrad. ex Hook.) Chev.

This fungus defoliated 1.5 million scotch pine seedlings in a private nursery in Langlade County. The 2-0 seedlings were sprayed with chlorothalanil and carried over. The 3-0 seedlings (about 700.000 were plowed under.

Diplodia Shoot Blight Diplodia pinea (Desm.) Kickx.

There was a 34.5% infection by Diplodia pinea in untreated red pine seed beds at Wilson State Forest Nursery, resulting in a loss of 300,000 seedlings. Research results at Wilson Nursery show that benomyl sprays applied to the foliage reduced the infection rate to less than 1%.

Walnut Seed Rot

Only 17% of the 700,000 black walnut seeds planted at Wilson State Nursery in Boscobel germinated in 1980. Usually between 40% and 50% of the seeds are viable. In 1980 seed germination averaged less than 20%. Bacteria in the genera Pseudomonas and Erwinia have been isolated from "soupy" nuts, and rot of nut meats has been induced by artifical inoculations with certain isolates. Decaying seeds were found on and under walnut trees in September. The possible role of the walnut husk fly (maggots) in disseminating these bacteria is being studied since husk decomposition precedes and overlaps the incidence of kernel rot. Research on the prevention and control of the rot is in progress at the University of Wisconsin.

Black Walnut Seedling Root Rot

In 1981 approximately 200,000 seedlings were destroyed because of root and collar rot that appeared to be caused by cold temperature injury to the roots. Various methods of mulching and overwatering will be utilized in 1982 in an attempt to prevent future losses.

APPENDIX A

History of a Spruce Budworm Outbreak in Wisconsin 1968-1981

The first indication of a spruce budworm outbreak was noticed in 1968 when very light defoliation of balsam fir occurred north of Monico in Oneida County. In 1969 light defoliation occurred on about 2000 acres in the same area.

The progress of the outbreak is shown in Figures 1 through 11. Most of the effected timber was balsam fir with some white spruce. A few white spruce plantations were severely defoliated. Populations built up in pole sized white spruce plantations and then moved into surrounding natural stands. A small pocket of defoliation that appeared in northern Forest county in 1971 and 1972 was eliminated by clear cutting the balsam fir stand. The defoliation peaked in 1980 at 180,000 acres and collapsed so that none could be seen from the air in 1981.

Salvage logging began on industrial land in 1971 before significant tree mortality became apparent. By 1974 tree mortality ranged from 7 to 50 percent in areas that had not been salvaged. By 1975 many private landowners were logging dying and threatened balsam fir stands. By 1979 about 11,000 acres of natural balsam fir stands suffered heavy mortality even though large areas were harvested. Much of the unsalvaged timber was in narrow strips along streams, in wet lands and on low hummocks in the midst of wetlands.

Most of the infested area is regenerating to balsam fir. Large areas outside the outbreak area are converting from aspen to balsam fir. Therefore, more outbreaks are anticipated in about 20 years.

Table 1 summarizes data collected during the course of the outbreak. The acres defoliated were estimated during aerial surveys.

An egg mass sample consisted of 6 branches from a permanent plot. A permanent plot consisted of a cluster of 3 trees. New plots were established as the infestation moved into new areas; some plots were eliminated by logging and tree mortality. Eggs were counted and parasitism recorded in the laboratory.

Branch samples for the overwintering larval mortality survey were taken in late April from at least six random locations within the infestation. Primarily old staminate cones were searched. The first 100 larvae found were examined for mortality and tallied.

TABLE 1. Summary of Spruce budworm outbreak statistics in Wisconsin from 1969 through 1981

Year	Light to Severe defoliation (acres)	Egg masses per 15" branch	Number of Branches Sampled	Egg Masses Parasitized	Overwintering larval mortality
1969	2000	-	--	--	
1970	6500	.19	120	--	--
1971	6700	.23	60	--	--
1972	9600	.39	108	--	--
1973	11750	2.38	180	--	--
1974	15500	.29	174	10%	19%
1975	55,000	.49	300	36%	24%
1976	104,000	1.20	360	37%	32%
1977	140,000	1.93	318	13%	20%
1978	140,000	1.15	384	3%	--
1979	140,000	2.0	570	11%	--
1980	180,000	.9	456	13%	
1981	none	.04	300	8 0%/est)	

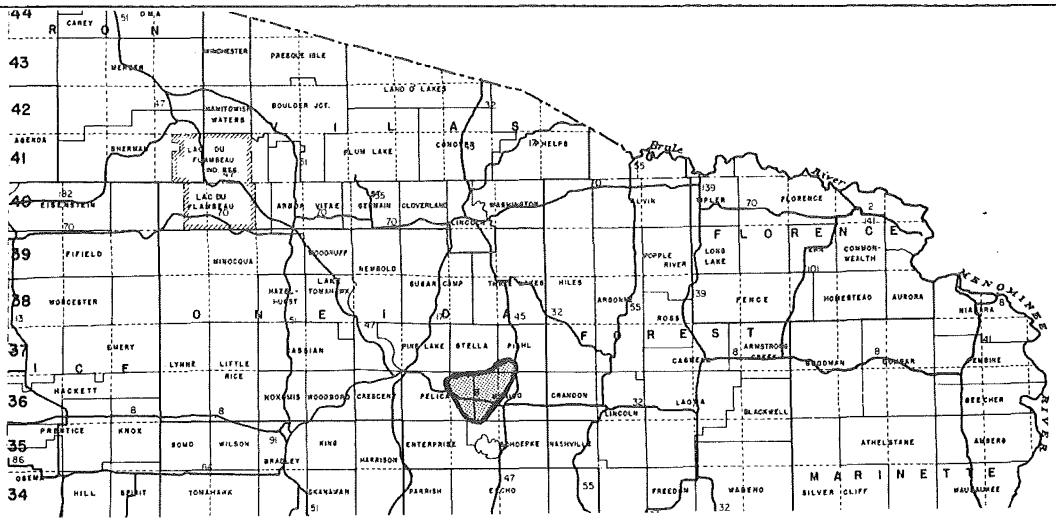

Figure 1. Area of Spruce Budworm defoliation, 1970.

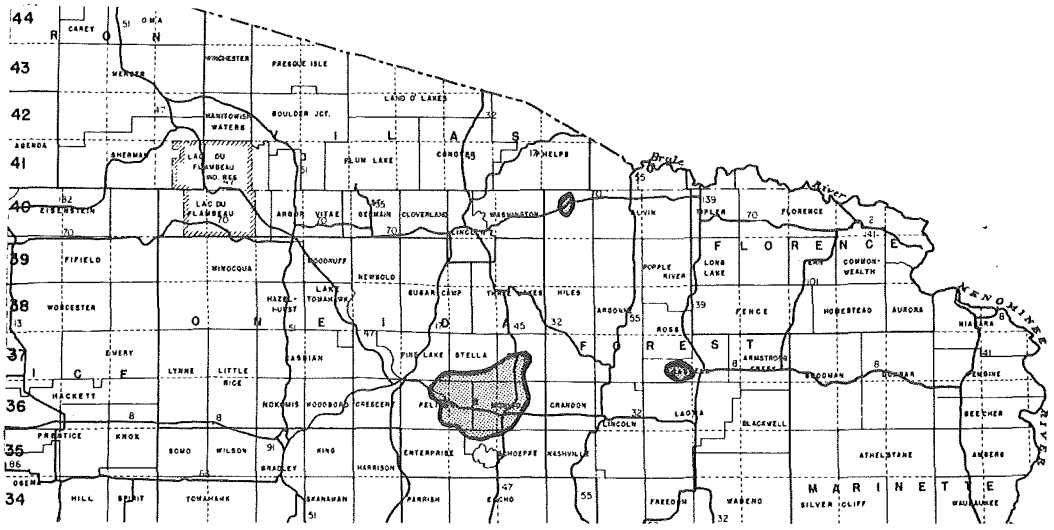

Figure 2. Area of Spruce Budworm defoliation, 1971.

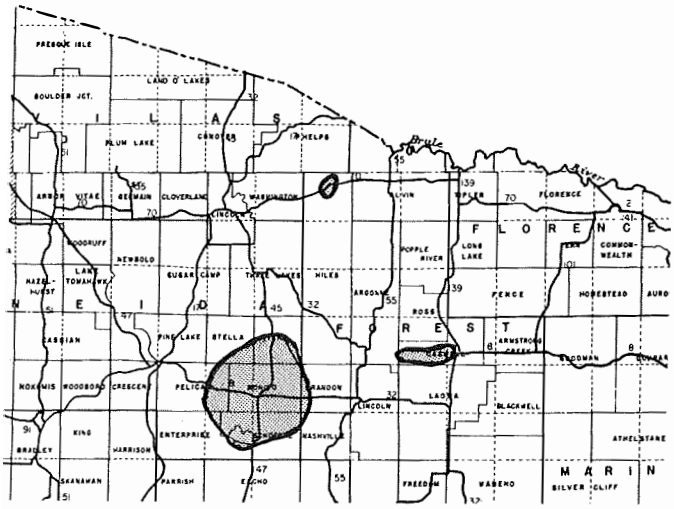

Figure 3. Area of Spruce Budworm defoliation, 1972.

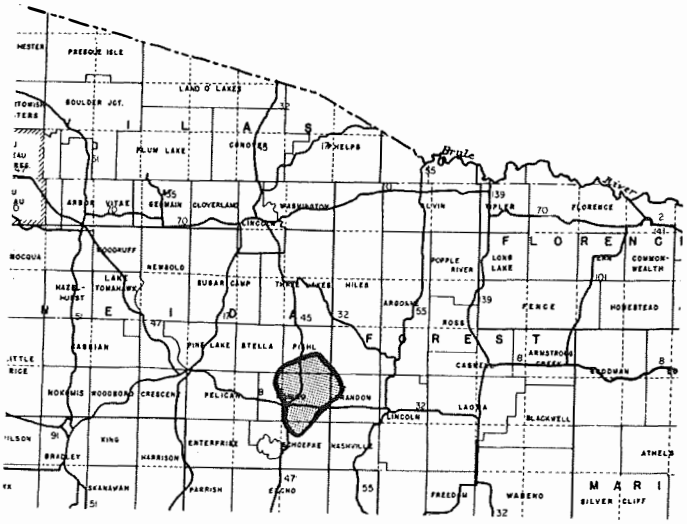

Figure 4. Area of Spruce Budworm defoliation,1973.

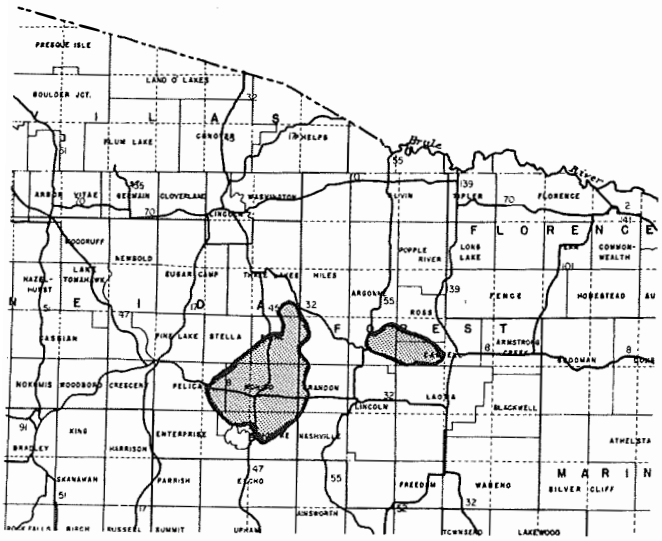

Figure 5. Area of Spruce Budworm defoliation, 1974.

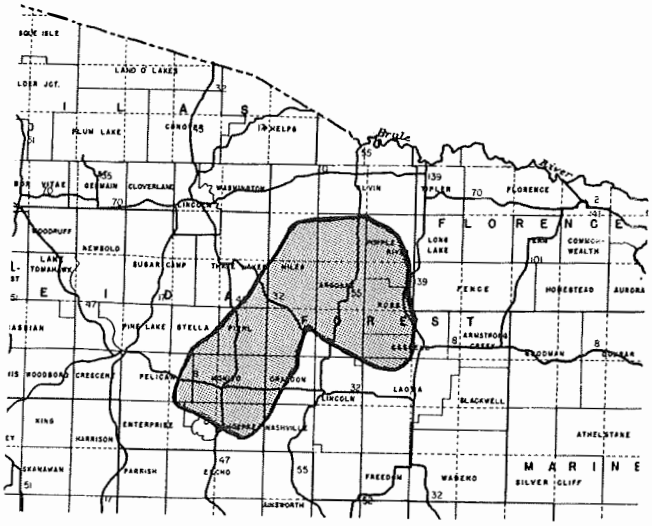

Figure 6. Area of Spruce Budworm defoliation, 1975.

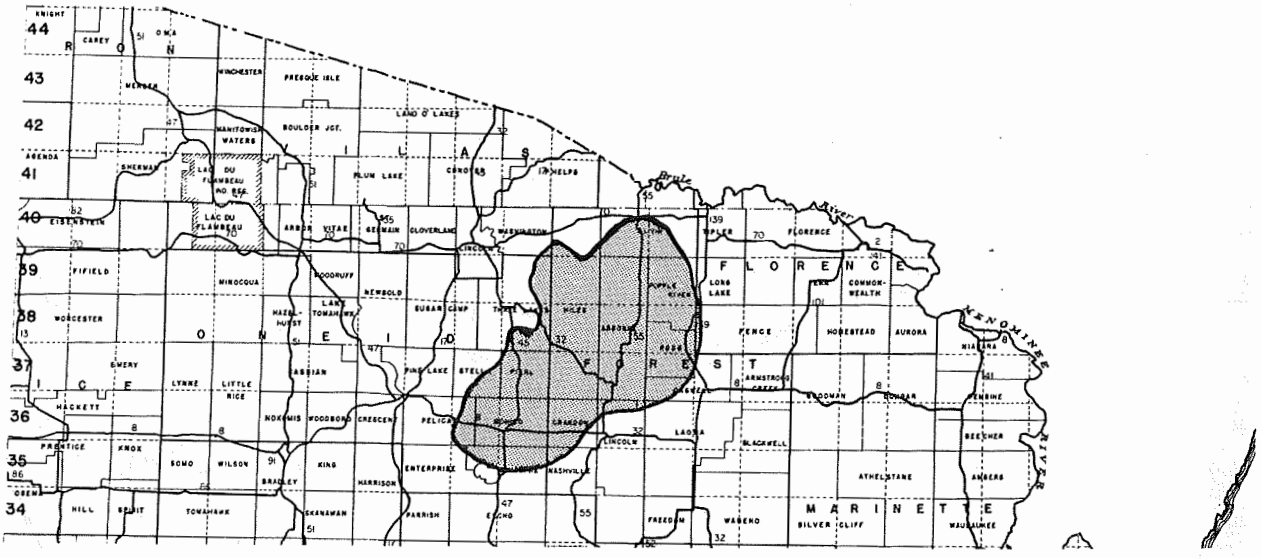

Figure 7. Area of Spruce Budworm defoliation, 1976.

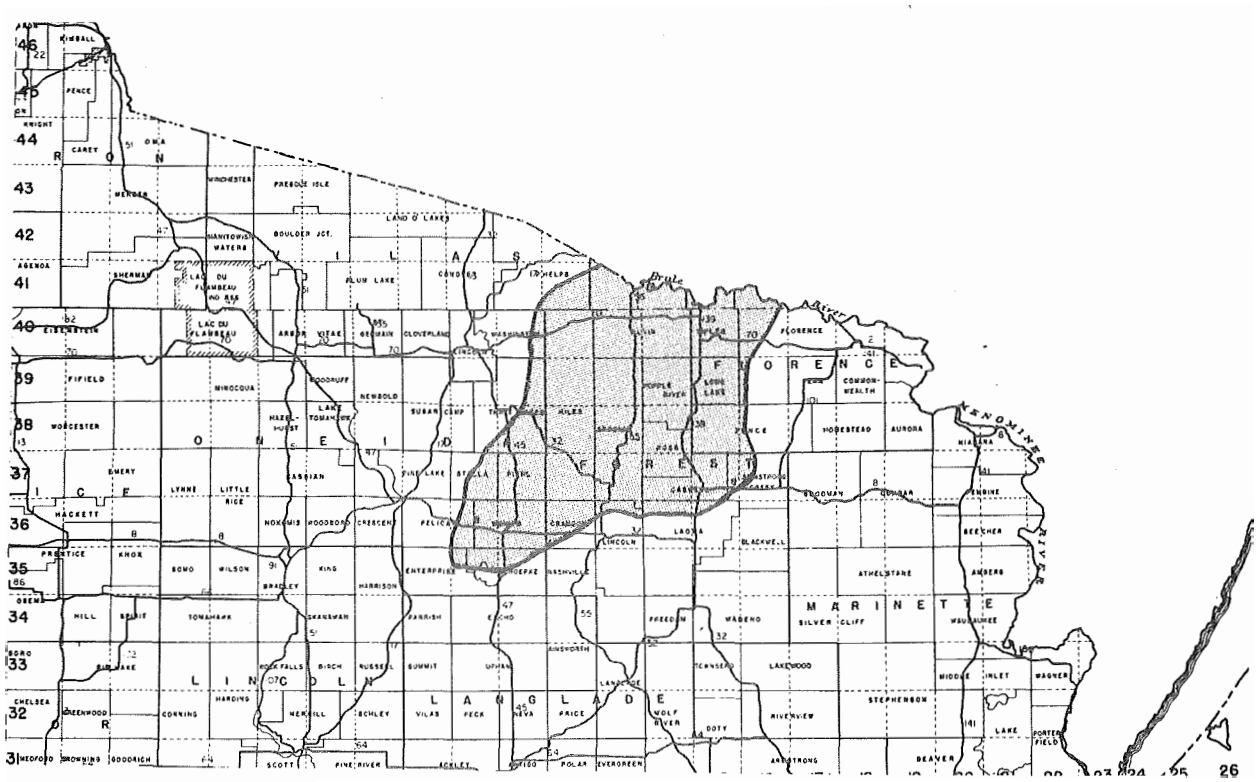

Figure 8. Area of Spruce Budworm defoliation, 1977.

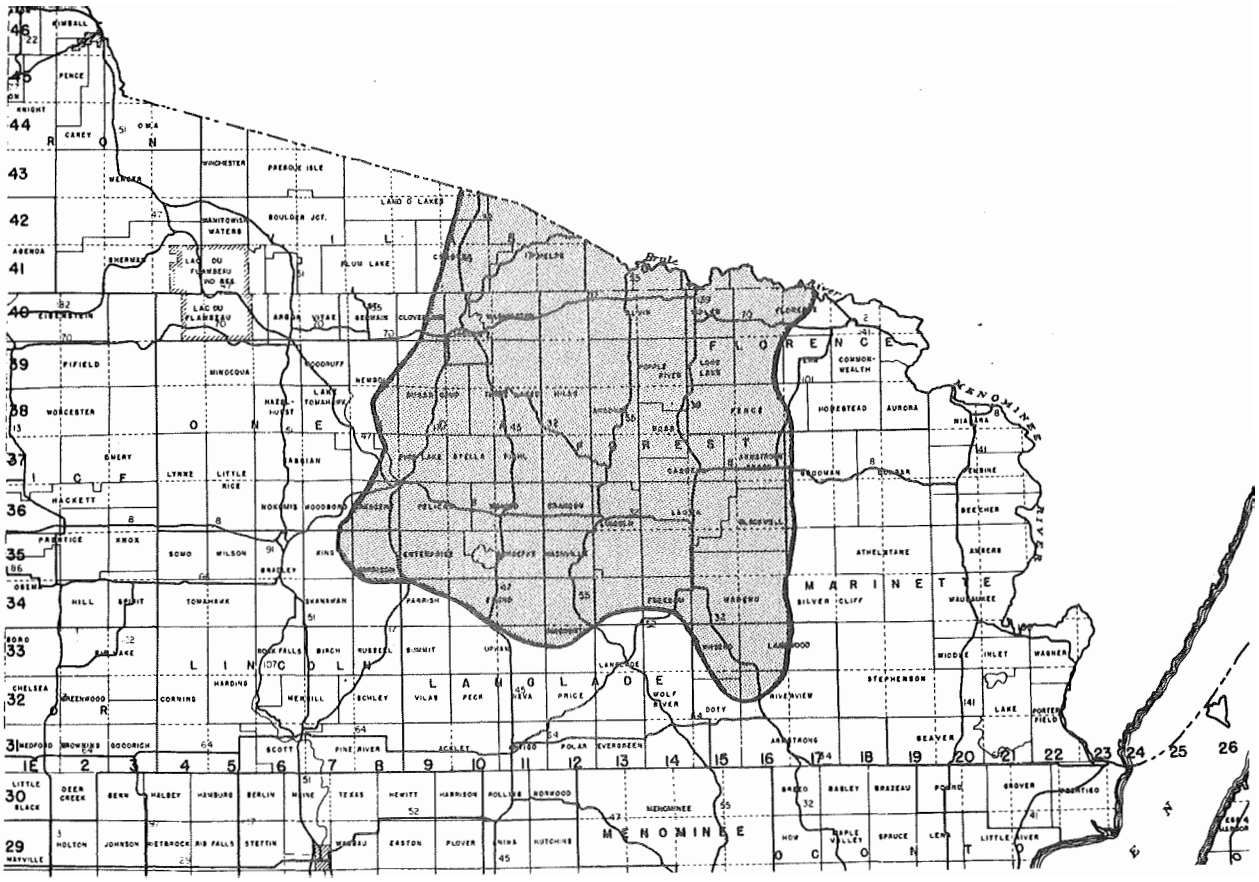

Figure 9. Area of Spruce Budworm defoliation, 1978.

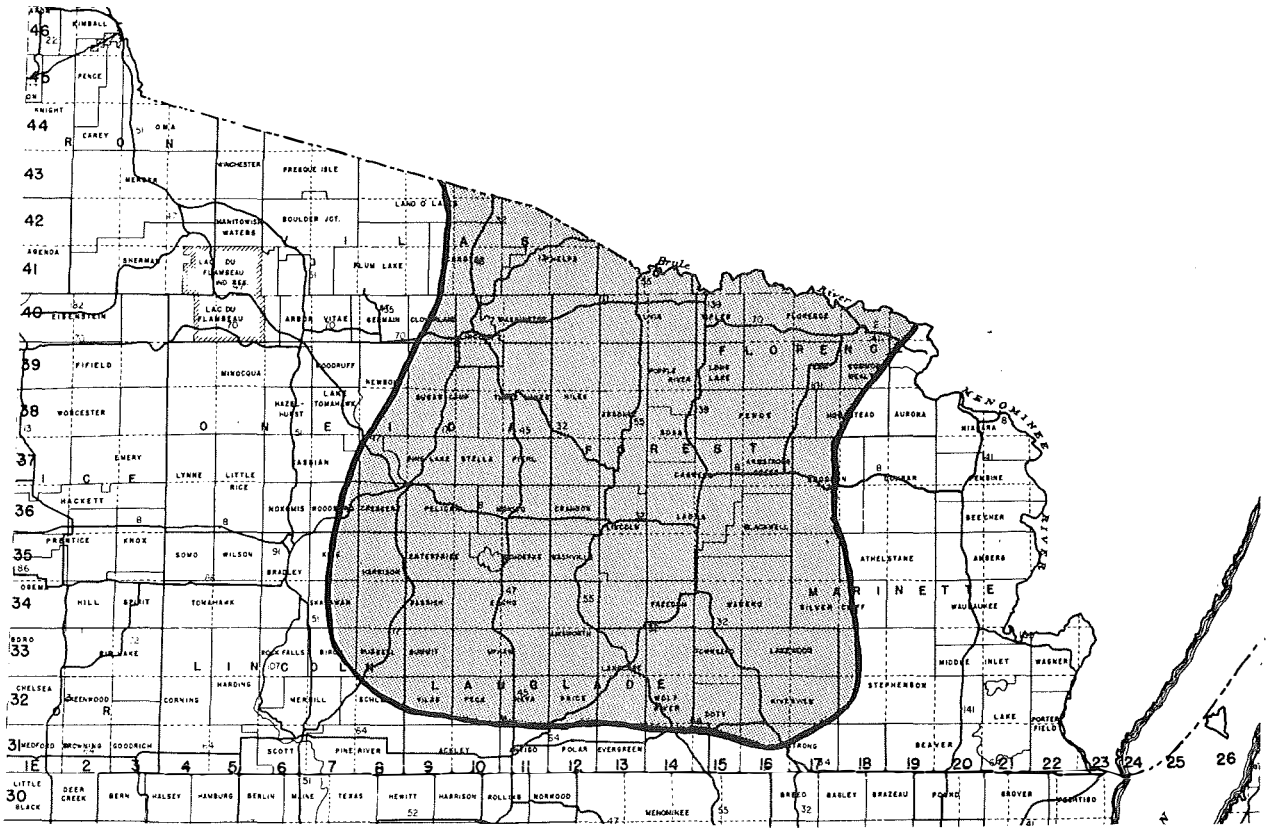

Figure 10. Area of Spruce Budworm defoliation, 1979.

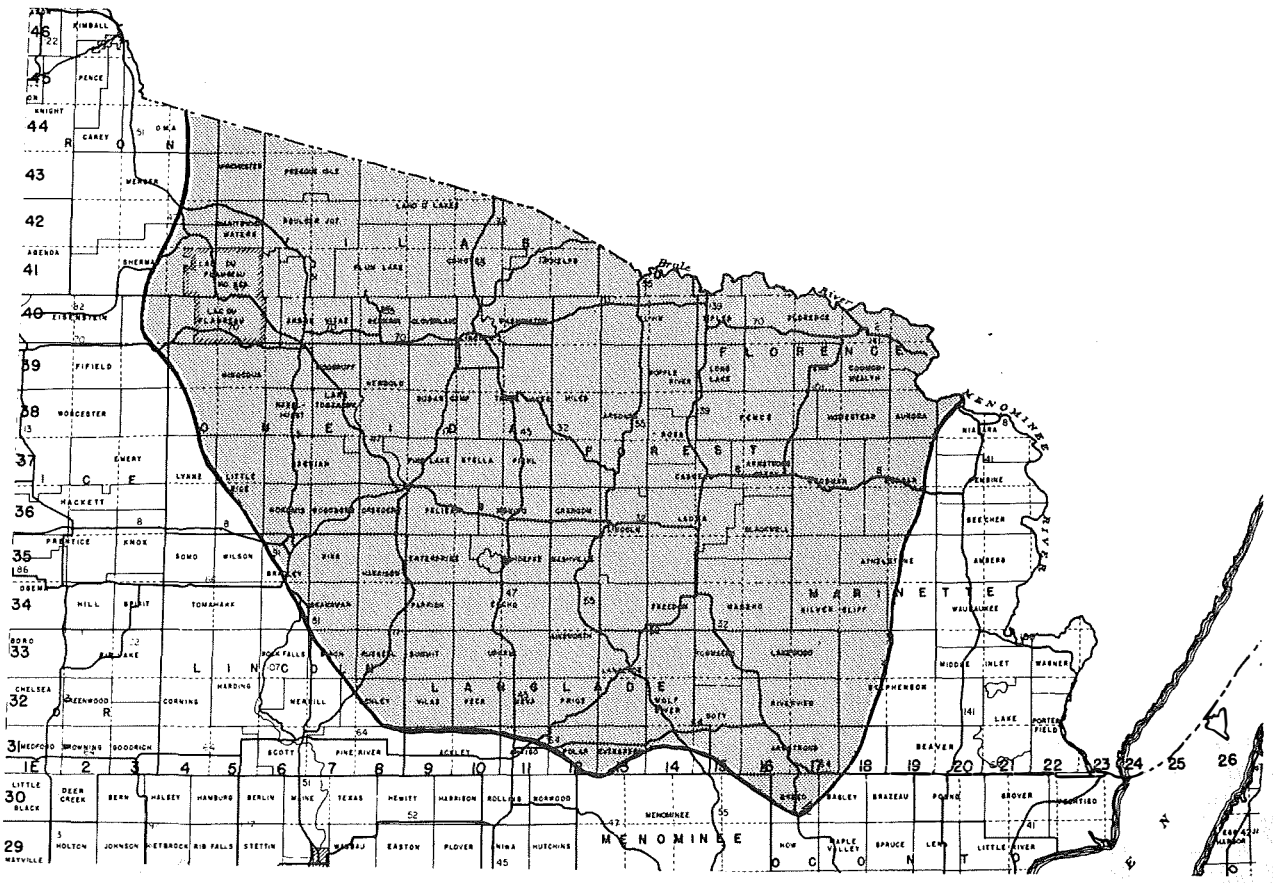

Figure 11. Area of Spruce Budworm defoliation, 1980.

APPENDIX B

Nursery Disease Control Preliminary Work Plan
Wisconsin - 1981

Swat Team Action and Responsibilities

I. Continue cover crop survey at Griffith Nursery. (Prey, Zarnstroff, and Berbee[1])

   A. Observe emergence and growth of red and white pine in cover crop area and investigate mortality and abnormal growth patterns.

   B. Take inventory of seedlings in cover crop area.

II. Trouble shoot at Griffith, Hayward, and Wilson Nurseries. (Prey and Zarnstroff)

   A. Collect seedling and soil samples when appropriate, and conduct laboratory work to determine what organisms are present.

III. Establish fungicide control plots for Diplodia shoot blight of red pine at Griffith and Wilson Nurseries. (Nicholls and Palmer[2])

IV. Continue to investigate the cause of white pine root rot at Griffith and Wilson Nurseries. (Palmer, Nicholls and Zarnstorff)

   A. Conduct serology tests to determine if isolates of Cylindrocladium from red pine, white pine, and white spruce are different in their species and pathogenicity towards the three hosts.

   B. Sample soil and seedlings at Griffith and Wilson Nurseries in white pine areas for Cylindrocladium.

   C. Sample soil from white spruce areas at Griffith Nursery.

   D. Monitor the growth of white pine in section G at Griffith Nursery and investigate any mortality.

V. Investigate the effect of planting depth on stunting of conifer seedlings. (Forward[3] and Nicholls)

VI. Analyze the soil from problem areas where appropriate and consult on stunting and white pine root rot investigations. (Iyer[4])

VII. Continue to investigate the pathogenicity and epidemiology of Fusarium oxysporum. (Berbee and Simmons[5])

VIII. Formulate possible studies on biological control of seedling diseases in the nursery. (Berbee)

IX. Continue to survey nurseries in Minnesota, Michigan, Iowa and Wisconsin for mycorrhizal fungi. (Croghan[6])

X. Continue to investigate the cause of walnut seed rot at Wilson Nursery. (Prey and Kuntz[7])

XI. Investigate walnut seed rot at Iowa State Forest Nursery and General Andrews Nursery in Willow River, Minnesota, and consult with Prey and Kuntz on Wisconsin walnut investigation. (Croghan)

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[3] Nursery Superintendent, USDA Forest Service, Toumey Nursery, Watersmeet, MI.
[4] Lecturer, Dept. of Soil Science, University of Wisconsin, Madison.
[5] Graduate student, University of Wisconsin, Madison.
[6] Plant pathologist, USDA Forest Service, State and Private Forestry, St. Paul, MN.
[7] Professor of plant pathology, University of Wisconsin, Madison.

APPENDIX C

EFFECT OF FUNGICIDAL SEED TREATMENT AND FUMIGATION ON GERMINATION AND SURVIVAL OF WHITE AND RED PINE AT GRIFFITH STATE FOREST NURSERY, WISCONSIN RAPIDS, WISCONSIN

BY

JANE E. ZARNSTORFF AND J. G. BERBEE[1]

INTRODUCTION

In 1980, a seed treatment and soil fumigation study was initiated at Griffith State Forest Tree Nursery, Wisconsin Rapids, Wisconsin. The objective of the study was to determine the effects of fungicidal seed treatment and soil fumigation on germination and survival of red pine and white pine. Fumigation of nursery soil with methyl bromide (MBC-33) is done to sterilize soil at Griffith nursery. The high cost (approximately $1,000/acre) and the unknown long term effects of fumigation on soil microorganisms have led the DNR pest control unit, and researchers at the University of Wisconsin, Madison, to explore alternative methods of controlling soil-borne plant pathogens and weeds. Treating seed with a fungicide is one way of decreasing the occurance of pre-emergence damping off. Tetramethylthiuram Disulfide (Thiram 42-S) is a fungicide registered for treatment of coniferous seeds to protect against damping-off organisms, and was chosen for use in this study.

MATERIALS AND METHODS

Red and white pine seed was treated by applying a spreader-sticker Plyac, at 95 ml/4.5 kg seed (.2 pint/10 lb). Tetramethylthiuram Disulfide (Thiram 42-S) was applied at 454 g active/4.5 kg seed (1 lb/10 lb). The treatments were applied in a cement mixer. The treated seed was spread out on plastic sheets to dry.

The seeds were planted at Griffith state forest tree nursery in Wisconsin Rapids on October 6, 1980. The experimental design is shown in Figure 1.

On June 3, and October 20, 1981, an inventory was made of the seedlings in each treatment. Twenty inventory plots per treatment, each 4'x1', were located with random numbers and the number of live trees were counted in each plot. Also, on October 20, four samples of 25 trees each were collected from each treatment for shoot-root ratio determination. The trees for shoot-root ratio determination were cut in half at the root collar, oven dried at 110oC for 24 h, and weighed.

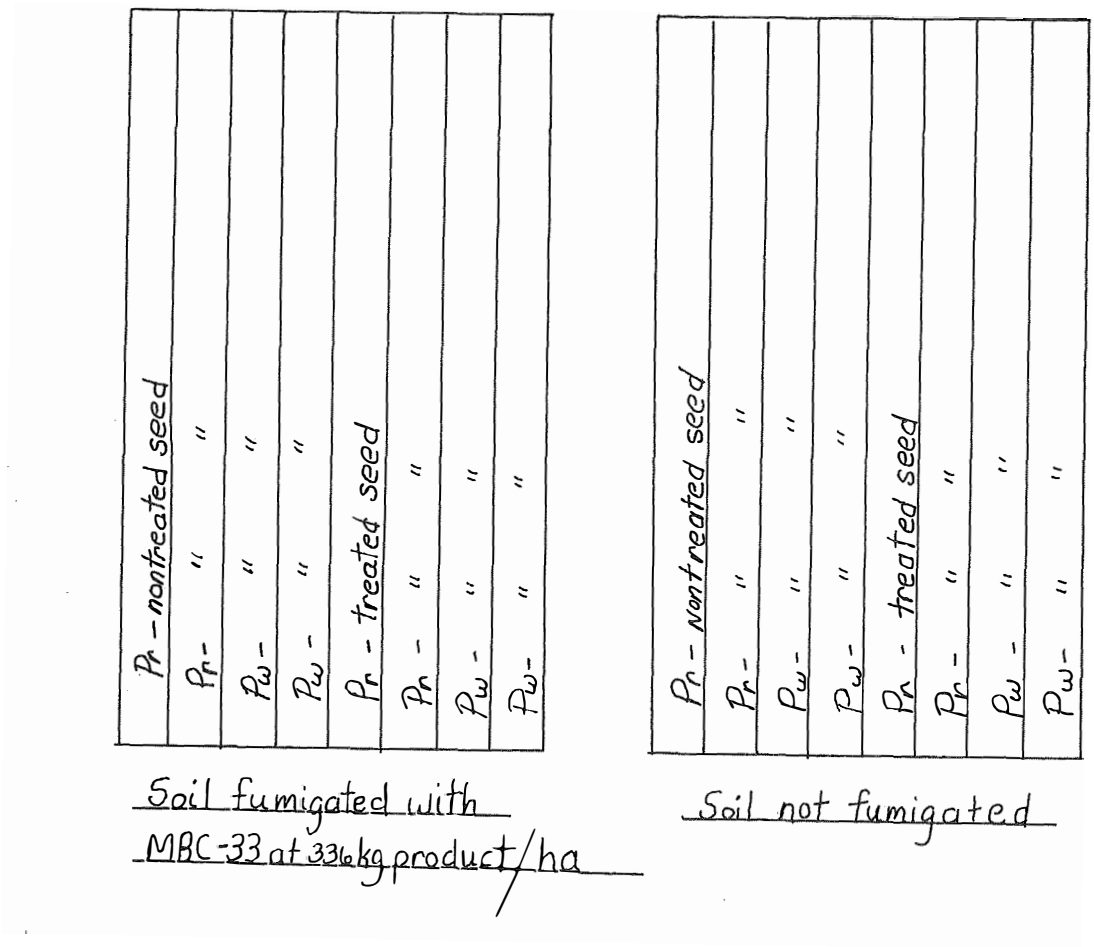
Germination and survival of red and white pine were compared between four treatments (Table 1).

TABLE 1. Seed and soil treatment combinations applied to red and white pine at Griffith State Forest Nursery, Wisconsin Rapids, Wisconsin

Treatment #	Seed treated with Thiram 42-S[1]	Soil fumigated with MCB - 332
1	+	-
2	-	+
3	+	+
4	-	-

[1] Thiram 42-S applied at 454 g active/4.5 kg seed (1b/10lb).
[2] Applied at 336 kg product/ha., September 30, 1980.

[1] Laboratory technician, Wisconsin Department of Natural Resources, and professor of plant pathology University of Wisconsin, Madison.


Pr - nontreated seed
Pr - " "
Pw - " "
Pw - " "
Pr - treated seed
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Pw - " "
Pr - nontreated seed
Pr - " "
Pw - " "
Pw - " "
Pr - treated seed
Pr - " "
Pw - " "
Pw - " "
Soil fumigated with MBC-33 at 336 kg product/ha
Soil not fumigated

Figure 1. Experimental design for evaluation of effects of fungicidal seed treatment and soil fumigation on germination and survival of white and red pine at Griffith State Nursery, Wisconsin Rapids, Wisconsin

RESULTS

A three-way analysis of variance was used on data collected on 21 October, 1981, to determine significant differences in the numbers of seedlings in the different treatments. The four factors considered in the three-way analysis were numbers of trees, tree species, fumigated soil or nofumigated soil, and pelleted or non-pelleted seed. The number of seedlings per square foot calculated from data collected on 3 June 1981, and 30 October 1981, is presented in Table 2.

TABLE 2. Number of red and white pine 1-0 seedlings per square foot at two sampling dates, in fumigated and nonfumigated soil and from treated and nontreated seed.

Tree species	Sampling date	Fumigated[a]		Nonfumigated	
		Pelleted[b] (no.)	Nonpelleted (no.)	Pelleted (no.)	Nonpelleted (no.)
Red pine	6-3-81	32	44	27	39
White pine	6-3-81	50	51	44	46
Red pine	10-20-81	27	43	21	30
White pine	10-20-81	45	49	32	36

[a]Fumigated with MBC-33 at 336 kg product/ha., September 30, 1980.
[b]A spreader-sticker (Plyac) was applied to seed at 100 ml/4.5 kg seed (.2 pints/ 10lb) and the seed was pelleted with the fungicide Thiram - 42S flowable, at .45 kg ai/4.5 kg seed (1 lb/10 lb).

The pooled number of white and red pine seedlings in the fumigated section is significantly (P=0.05) greater than the number of seedlings in the nonfumigated section. The pooled number of red and white pine seedlings from treated seed was significantly lower than the number of seedlings from nontreated seed, but the difference in white pine pelleted and nonpelleted was not as apparent as the difference in red pine.

Biomass survey results are presented in Table 3. In the red pine seedlings, there is an apparent higher shoot weight of the seedlings that developed from pelleted seed. There was no significant difference in the shoot/root ratios of the white pine from pelleted and nonpelleted seed.

TABLE 3. Shoot/root ratio of red and white pine 1-0 seedlings at Griffith State Nursery, Boscobel, WI, from fumigated and nonfumigated soil, and pelleted and nonpelleted seed.

Tree Species	Fumigated[a]		Nonfumigated	
	Pelleted[b] (no.)	Nonpelleted (no.)	Pelleted (no.)	Nonpelleted (no.)
Red pine	5.85	3.96	2.11	1.78
White pine	2.33	2.43	1.87	2.03

[a]Fumigated with MBC-33 at 336 kg product/ha., September 30, 1981.
[b]A spreader sticker (Plyac) was applied to seed at 100 ml/4.5 kg seed (.2 pints/10 lb) and the seed was pelleted with the fungicide Thiram - 42S flowable, at .45 kg ai/45. kg seed (1 lb/10 lb)

DISCUSSION

The higher number of seedlings in the fumigated section indicates mortality due to damping-off was probably decreased. The pelleting appears to have reduced the number of seedlings. This may be a result of a fungicide seed pelleting application rate that was too high or too low, or an inhibition of germination by the spreader - sticker because of its hydrophobic nature. A test to determine the effects of various rates of application of the fungicide to the seed is recommended.

The shoot growth was greater in the red pine from pelleted seed than from nonpelleted seed probably because of the lower density of seedlings in the seed pelleted area due to lower germination. The lower seedling density would provide a situation for less competition between trees for light, moisture, and nutrients.

APPENDIX D

WALNUT SEED SOFT ROT SURVEY IN TWO MIDWESTERN NURSERIES

by
Catherine F. Croghan[1]

In the fall of 1979, 700,000 walnut seeds were planted at Wilson Nursery, Boscobel, WI. At the typical germination rate of 50 percent, the expected crop was 350,000 seedlings. However, the germination rate in 1980 was only 20 percent. Upon examination, many of the non-germinated seed were found to contain bacterial soft rot. Because of the soft rot, fewer than 150,000 1-0 seedlings were available for outplanting in the spring of 1981. At 11 cents per seedling, the difference between expected and realized crop value was $22,000.

As part of our cooperative pathology effort with the Wisconsin Department of Natural Resources, Forest Pest Management, we conducted a survey for walnut seed soft rot in two additional nurseries: Iowa State at Ames, Iowa and General Andrews at Willow River, Minnesota. The survey was conducted to determine if walnut seed rot was occurring at other nurseries in the region and to determine if particular seed and seedbed preparation practices were associated with high levels of soft rot.

Bacterial soft rot was found at both the Iowa State and General Andrews Nurseries. The percent walnut seed soft rot at General Andrews Nursery (56%) was comparable with that observed for Wilson Nursery (43%). However, the incidence of soft rot at Iowa State Nursery (20%) was considerably less than Wilson Nursery.

An examination of the cultural practices at the 3 nurseries showed many similarities between General Andrews and Wilson Nurseries. The primary difference between these two nurseries and the Iowa State Nursery was in the manner of seed preparation and seeding. Unlike General Andrews and Wilson Nurseries, Iowa State did not husk its seed. Also, rather than covering the seeds with soil, Iowa State mulched the seedbeds with corn cobs.

The results of this survey indicate that while soft rot is present in all three nurseries examined, cultural practices such as husking and sowing technique may be associated with increased incidence. We have recommended that a single seed lot be evaluated for the effects of husking and sowing technique on percent microbial colonization, specifically bacterial soft rot.

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APPENDIX E

SURVEY FOR ENDEMIC NURSERY MYCORRHIZAE

by
Catherine F. Croghan[1]

The endemic nursery mycorrhizae survey was initiated in 1980 to identify species of known mycorrhizae forming fungi that occur in the forest tree nurseries of the region. The results for the 2nd year of this 3 year survey are summarized below.

Nurseries in Iowa, Michigan, Minnesota and Wisconsin participated; with six State and two Federal nurseries making collections. Collections received in 1981 included six species that are known to be mycorrhizal associates: Boletus sp., Thelephora terrestris Ehrh. ex Fr., Hebeloma arenosum[2], Laccaria laccata (Fr.) Berk and Br. Inocybe sp., and Tylopilus fellius (Bull. ex Fr.) Karst. As in 1980, T. terrestus, L. Laccata and H. arenosum were received from all participating nurseries. T. felleus was the only new species collected in the 1981 survey.

Collections were made in nursery beds of six different tree species. These included white spruce, black spruce, Norway spruce, red pine, jack pine, and Eastern white pine. The Hebeloma occurred in association with all six species. The Boletus sp. and the T. felleus were each found with only one tree species (red pine and white pine, respectively).

The Inocybe sp., T. felleus, and Boletus sp. collections were much less frequent than the other three fungal species. It should be pointed out however, that this low frequency may not be a reflection of the actual appearance in the nursery beds but a reflection of color, size, and persistence of the mushrooms. A bright colored, large fruiting body that resists decay is much more likely to be collected than one that lacks these characteristics.

[1] Plant pathologist, USDA Forest Service, State and Private Forestry, St. Paul, MN
[2] H. arenosum is a new species name. It will be published in the forthcoming A. H. Smith/L. R. Hesler Hebeloma monograph. The description is based on collections made by M. Albers, Pest Specialist, Minnesota Department of Natural Resources, at the Griffith Nursery in Wisconsin Rapids, Wisconsin and on a collection from Oregon.

APPENDIX F

Epidemiology of Damping-off Caused by *Fusarium oxysporum*[1]

by
Scott Simmons[2]

Fusarium spp. were associated with a root rot of white pine seedlings in Wisconsin's State Forest Nurseries. *F. oxysporum* was the species most commonly isolated.

Fusarium oxysporum isolates obtained from root-rotted white pine and damped-off red and white pine seedlings caused damping-off of pine seedlings. The fungus penetrated stomates on red pine seedling hypocotyls and penetrated seedling radicles directly colonizing the root cap and epidermal surface, penetrating epidermal and cortical cell walls directly, and heavily colonizing a few inner cortical cells and radiating out from these cells through the endodermis and into the vascular cylinder. Root hairs were also directly penetrated and colonized by the fungus.

At least 36 h of moist conditions were required for infection of seedling hypocotyls to occur. Temperatures of 20 C to 36 C were most favorable for *Fusarium* damping-off. Germinating seedlings at 36 C or incubating them at 36 C for 4 days prior to inoculation increased their susceptibility to infection by *F. oxysporum.*

The white pine root rot was not present in a seedbed that had not been fumigated in Griffith Nursery. More organisms antagonistic to *F. oxysporum* in culture were present in the rhizosphere of seedlings growing in this soil than were present in the rhizosphere of seedlings growing in soil that had been fumigated before planting.

[1] Abstract from M. S. thesis on file at University of Wisconsin, Madison, plant pathology library.
[2] Graduate student, University of Wisconsin, Madison.

APPENDIX G

Summary of 1981 Research Results: Diplodja pinea

by M. A. Palmer and T. H. Nicholls[1]

The main objective of our 1981 field work was to further test effectiveness of the fungicide benomyl against Diplodia pinea and to identify other chemicals that could be used to control this fungus in nursery seedbeds. We also initiated a study to identify the period of susceptibility of one-year-old red pine seedlings to Diplodia shoot blight. Both the Griffith and Wilson State nurseries participated in this study. In addition, a study to determine the major Diplodia inoculum sources in nurseries was established at the Black River Falls State Forest.

Chemical Trials

Benomyl, Topsin and Duter were applied to small plots of 2-0 and 3-0 red pine at both nurseries. As in other years, benomyl provided the best control. Topsin and Duter did not provide effective control.

Three spray schedules were used at Wilson nursery to identify proper timing of fungicide application to protect 1-0 seedlings. Seedbeds were sprayed with benomyl at two-week intervals beginning either in June, July, or August. There appears to be no difference in the amount of seedling mortality whether seedlings received 6, 4, or 2 sprays. Thus, fungicide application in August may be all that is necessary to protect 1-0 seedlings from infection. This will be verified by repeating the study during the 1982 field season. Mortality of 1-0 seedlings from D. pinea infection was estimated from unsprayed plots. At Wilson nursery 35% of the 1-0 red pine seedling inventory would have been killed if seedlings had not been sprayed.

At Griffith nursery, 1-0 seedlings were sprayed on alternate weeks mid-June through August. Spray effectiveness for this age class could not be determined at this location since only 2.3% infection was observed in unsprayed plots.

Inoculum Sources

In order to determine the major sources of Diplodia inoculum in nurseries, spore dispersal from several types of infected tissues was studied at Black River Falls State Forest. Infected red pine seedlings, cones, litter, and bole and branch cankers were placed in wire screens and positioned above small plots of healthy 2-0 red pine. Screens without inoculum served as the control. Each inoculum source plot was replicated twice. Three spore traps were placed beneath each screen. The greatest amount of seedling mortality and the most spores were trapped beneath screens holding cones or seedlings. However, under one screen with cones, few trees were killed and only a small amount of spores were trapped, indicating that not all cones harbor abundant inoculum. This study will be repeated in 1982 and the variability in cone inoculum studied more thoroughly.

Red pine seed from lots planted in all Wisconsin nurseries in the fall of 1981 was examined in the laboratory to determine if D. pinea is a seed borne pathogen. Diplodia spores were not observed when seeds were examined under the microscope and the fungus was not recovered when seed was incubated on Potato Dextrose Agar.

Plans for 1982

During the 1982 field season, we will continue fungicide studies to acquire the necessary data for EPA registration of benomyl. Although we may have identified the period for fungicide application to protect seedlings from infection, we still do not know the source of inoculum or how spores are dispersed throughout the nursery seedbed. We will be critically analyzing the Dipodia epidemic in seedbeds of 1-0 red pine, as serious economic losses have occurred in this age class. Inoculum source and spore trapping studies in Black River Falls State Forest will also be continued in 1982. Sources of Diplodia inoculum, once identified, can be treated or removed. This, in combination with fungicide sprays will enable nursery managers to reduce or eliminate seedling losses caused by Diplodia.

We wish to thank our cooperators, Al Prey, Frank Morse, Dick Camp, John Borkenhagen and Ken Wojahn for their help with these studies.

[1] Assistant and principal pathologist, USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN

APPENDIX H

Summary of 1981 Research Results: White Pine Root Rot

by M. A. Palmer and T. H. Nicholls[1]

Our SWAT team objectives for 1981 field work were to confirm Cylindrocladium as the cause of white pine root rot at the Griffith and Wilson nurseries, and to identify if possible the best time of year to recover the fungus from infected tissues or soil.

This year, the root rot epidemic was studied at Wilson Nursery. Fifty plots were established in a 3-0 mylone - fumigated white pine seedbed (section 846). Plots were sampled throughout the early part of the field season on April 15, May 12 and 27, June 9 and 22 and finally on August 12. On each sampling date, symptomatic and healthy seedlings were collected from each plot, soil samples were collected for geranium baiting (a technique to determine qualitatively the presence of Cylindrocladium in the soil), and seedling mortality was recorded. Seedling and soil samples were also collected from methyl bromide fumigated 3-0 white pine in section 845. In order to compare Cylindrocladium recovery from white pine to that of white spruce, seedling and soil samples were collected from a mylone-fumigated 3-0 white spruce seedbed (section K) at Griffith Nursery.

In the laboratory, seedling roots were incubated on plates of modified Glucose-Lima Bean agar, a medium specific for Cylindrocladium spp. As in past years, isolation results were quite variable. Cylindrocladium recovery ranged from 2-20% from white pine in mylone-fumigated section 846, Wilson Nursery. Cylindrocladium was recovered from only a few isolations of white pine in methyl bromide-fumigated section 845, Wilson nursery. Recovery of the fungus from white spruce in section K, Griffith Nursery, was consistently high, ranging from 70-96%.

The results of geranium baiting were similar to isolation results. Recovery of Cylindrocladium ranged from 2-16% in mylone-fumigated white pine, whereas in the white spruce, recovery ranged from 44-84%.

There was no sampling date where Cylindrocladium was recovered in consistently high amounts from white pine seedbeds from both geranium baiting and root isolations. However, this years results, when combined with 1980 data indicate that the fungus may be more readily recovered in spring or early summer in contrast to late summer or fall.

White pine seedling mortality caused by root rot averaged about 10% throughout the growing season in mylone-fumigated section 846.

Study of the white pine root rot epidemic at Wilson Nursery indicate that Cylindrocladium is an important component of this problem. Although the fungus was recovered in low levels from seedling and soil samples, combined data from the last three sampling dates indicates that Cylindrocladium was recovered from 24 of the 50 plots either through geranium baiting or isolations from white pine roots.

In culture, there are distinct morphologic differences between Cylindrocladium isolates from white spruce and white pine. As noted above, recovery of this fungus is much greater from white spruce than white pine. These two differences indicate that there may be two different strains of the fungus present in nursery soils. During 1982, we plan to study this variability. The two fungal isolates will be tested in greenhouse studies to try to confirm the differences in pathogenicity observed in the field. Culture will also be tested serologically to determine if protein differences exist between the two isolates.

We wish to thank our cooperators, Dick Camp, Al Prey, and Ken Wojahn for their help with these studies.

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